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An Econometric Investigation of the Impact of Governmental Support Programs on the Production and Disappearance of Important Varieties of Dry Edible Beans

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AN ECONOMETRIC INVESTIGATION OF THE IMPACT OF GOVERNMENTAL SUPPORT PROGRAMS ON THE PRODUCTION AND DISAPPEARANCE OF IMPORTANT VARIETIES OF DRY EDIBLE BEANS

by

R. J. Vandenborre[1/]

Introduction

Dry edible beans are usually divided into three main groups: white varieties, colored varieties, and "other classes." The white varieties include navy or pea beans, small whites, and great northerns; pinto and red kidney beans are important colored varieties; and small limas, large limas, and blackeyes are predominant in other classes. Since World War II, all of these varieties, except blackeyes, have been produced under the United States price-support program for agricultural commodities. Commodity Credit Corporation (CCC) acquisitions were considerable in the early 1950's and have continued to be large for navy beans to the present day. Since 1955, however, acquisitions of other varieties have been unimportant.

The purpose of this study is to evaluate the impact of governmental support programs on the production and disappearance of some varieties of dry edible beans, specifically whites, limas, and blackeyes. Primarily, the study attempts to answer this question: What would have been the situation with respect to production and disappearance of these commodities had there been no price-support program for them? To find an answer to this question,

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it was first necessary to investigate the economic relationships in the growing stage and to conduct a price-demand analysis. The resulting estimate of the parameter structure underlying production and demand-price response could then be used as a basis for evaluation of governmental price-support programs.

It is believed that there are unique aspects to this study. First, rather than focusing attention on a single commodity, a group of commodities is treated simultaneously; second, explicit consideration is given to the cross forces of production and demand interrelationships; and, third, effects of government programs on both controlled and noncontrolled commodities are considered.

The Dry Edible Bean Sector of the United States Agricultural Economy

Geographical Distribution of Production

The U. S. Department of Agriculture compiles data on production for 12 major varieties of dry edible beans.[1] While a number of these are produced in several different states, others are grown in but a single state, and some in only a few counties within a state.[2] The main reason for this phenomenon is that beans tend to require specific climatological conditions for normal growth.[3] The distribution of dry edible bean production among the states is shown in Table 1.

Production, Consumption, and Prices

Production of dry edible beans as a group has risen substantially over the last 15 years--from approximately 15 million hundredweight (cleaned basis)

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[1] U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964, 31p.

[2] Dale E. Hathaway, The Effects of the Price Support Program on the Dry Bean Industry in Michigan, Michigan Agricultural Experiment Station Technical Bulletin 250 (East Lansing, 1955), p. 6.

[3] Ibid.

TABLE 1

Geographical Distribution of the Production of Dry Edible Beans by Major Varieties
10-Year Average, 1954-1963

Variety	California	Colorado	Idaho	Michigan	Montana	Nebraska	New Mexico	New York	Washington	Wyoming	Other	Total
	percent											
Navy	0.0	0.0	0.0	98.6	0.0	0.0	0.0	1.3	0.0	0.0	0.1	100
Great northern	0.0	0.0	24.7	0.0	3.2	38.9	0.0	0.0	0.5	20.1	12.6	100
Small white	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Flat white	31.2	0.0	19.5	0.0	0.0	0.0	0.0	0.0	49.3	0.0	0.0	100
Pinto	0.2	41.4	28.6	0.9	3.7	4.5	2.6	0.0	4.1	11.1	2.9	100
Red kidney	14.1	0.0	0.0	17.9	0.0	0.0	0.0	65.4	0.0	0.0	2.6	100
Pink	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	100
Small red	7.7	0.0	28.8	0.0	0.0	0.0	0.0	0.0	62.8	0.0	0.7	100
Cranberry	15.4	0.0	0.0	84.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Large lima	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Baby lima	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Blackeye	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Other[a]	29.0	0.0	41.0	8.0	0.0	0.0	0.0	21.0	1.0	0.0	0.0	100

[a] Percentages slightly adjusted to total 100.

Source: U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964, 31p.

in the early 1950's to about 19 million hundredweight (cleaned basis) by the end of that decade and the early 1960's. Growth has not been proportionate for all categories, however. The increase in total production of dry edible beans has been due exclusively to the expansion of one white variety, namely, navy beans. Production of this variety has risen in the last 10 years from 3.5 to 7.0 million hundredweight. Production of lima beans, on the other hand, has been declining but seems recently to have stabilized around 1.3 million hundredweight. Meanwhile, production of the important colored varieties has fluctuated around 7 million hundredweight. Production of dry edible beans, by classes, has been summarized in Table 2 for 1950-1963.

An important question to be considered relates to whether production increases have come from acreage increases or yield increases per acre. Although data on planted and harvested acreage per variety of beans are scarce, it was possible to make a comparison between the yield (cleaned basis) per harvested acre for navy beans and large and small limas. When the average for the crop years 1960-1963 was compared with the 1948-1951 average, it was found that yields per acre increased 35 percent for navy beans, 0 percent for large limas, and 16 percent for small limas. Yearly yields for these three varieties are given in Table 3.

It should be noted that the difference in yield increase between navy and lima beans, as shown in Table 3, is biased downward. There has been a slight increase in the total acreage grown to navy beans and a considerable decrease in lima bean acreage. It is probably realistic to assume that additional acres grown to a crop are less and less productive; therefore, since the changes in acreage of the two varieties have been opposite, increasing for navy beans while decreasing for limas, the differential in yield response must be biased downward.

TABLE 2

Production of Dry Edible Beans by Varieties, Cleaned Basis, 1950-1963

Year[a]	White				Colored					Other			
	Navy	Great northern	Small white	Total	Small red	Pink	Pinto	Red kidney	Total	Large lima	Small lima	Black-eye	Total
	1,000 hundredweight												
1950	3,356	1,720	466	5,542	486	336	3,630	1,123	5,575	1,225	1,132	611	2,968
1951	4,072	1,469	736	6,277	768	534	2,980	1,344	5,626	1,168	798	918	2,884
1952	3,412	1,872	540	5,824	605	393	3,143	1,421	5,562	1,360	430	647	2,437
1953	3,601	1,707	560	5,868	666	450	4,782	1,249	7,147	1,137	639	767	2,543
1954	3,158	1,956	731	5,845	1,217	656	4,537	1,155	7,565	1,259	758	703	2,720
1955	4,428	1,949	884	7,261	1,018	414	3,589	1,045	6,066	1,077	318	962	2,367
1956	5,020	1,809	771	7,600	757	400	3,351	1,863	6,371	1,024	559	654	2,237
1957	3,358	1,501	759	5,618	750	399	4,913	1,307	7,369	943	345	793	2,081
1958	5,042	2,035	800	7,877	1,490	457	4,903	1,379	8,230	1,093	356	918	2,367
1959	6,069	2,256	943	9,268	871	269	4,381	988	6,509	916	412	841	2,169
1960	5,845	1,572	618	8,035	733	314	4,475	1,474	6,996	756	467	570	1,793
1961	6,755	1,678	438	8,871	360	457	5,592	1,555	7,964	774	454	966	2,194
1962	6,725	1,469	542	8,736	534	323	4,062	1,579	6,498	950	521	648	2,119
1963	7,522	2,282	619	10,423	424	323	4,700	1,702	7,149	781	540	770	2,091

a/ Beginning September 1.

Source: U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964, 31p.

TABLE 3

Yields Per Harvested Acre of Dry Edible Beans by Varieties, Cleaned Basis 1948-49 through 1963-64

Year[a]	Navy	Large lima	Small lima
	hundredweight		
1948-49	844	1,634	1,312
1949-50	1,060	1,496	1,533
1950-51	788	1,725	1,572
1951-52	1,064	1,717	1,535
1952-53	1,056	1,679	1,775
1953-54	1,008	1,672	1,763
1954-55	798	1,725	1,325
1955-56	899	1,496	1,863
1956-57	1,080	1,707	2,030
1957-58	740	1,546	1,618
1958-59	975	1,656	1,716
1959-60	1,259	1,527	1,868
1960-61	1,189	1,543	1,621
1961-62	1,287	1,647	1,737
1962-63	1,480	1,792	1,737
1963-64	1,140	1,627	1,800

[a] Beginning September 1.

Source: Computed from data in U. S. Department of Agriculture, Agricultural Statistics, annual issues.

Commercial disappearance of white varieties, limas, and blackeyes combined is now at about the same absolute level as 15 years ago; and bean prices have not changed much either.[1] A comparison of the period 1959-1963 with 1948-1952 shows that the net increase in disappearance for all varieties analyzed was about 5 percent. For separate categories, increases in disappearance occurred as follows: blackeyes, 9 percent; all white varieties, 15 percent; and navy beans, 32 percent. For lima beans, however, there was a decrease in disappearance of 31 percent. Meanwhile, during the same time span, population increased 21 percent and incomes also increased. Thus, per capita consumption of this group of beans has been declining while incomes have been rising--a phenomenon that has led people to call beans an ingredient of a poor man's diet.

Commercial disappearance of some varieties of dry edible beans is summarized in Table 4 for 1948-49 through 1962-63.

Available export data for dry edible beans appear to be primarily ad hoc "best guesses." They combine commercial sales, sales for export of government-held beans, and donations for export of government-held beans. Export sales and export donations of government-held beans have varied widely from year to year and, as a consequence, so have total exports.

The available information on export operations in some classes of dry edible beans has been summarized in Tables 5 and 6. Two examples will illustrate the unreliability of the data. First, total exports of navy beans for 1956-57, as reported, were less than sales for export from CCC stocks alone. Second, donations of large limas were reported to be 420,000 hundredweight in

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[1] Commercial disappearance is defined as production and starting stocks minus ending stocks minus government takeover minus direct government purchases. In the case of navy beans, domestic sales by government are added.

TABLE 4

Commercial Disappearance of Dry Edible Beans by Varieties, Cleaned Basis
1948-49 through 1962-63

Year[a]	White				Colored		
	Navy	Great northern	Small white	Total	Limas	Blackeye	Total
	1	2	3	4	5	6	7
	1,000 hundredweight						
1948-49	3,880	2,423	475	6,778	1,632	859	9,269
1949-50	3,074	1,746	649	5,469	2,034	530	8,033
1950-51	4,792	1,988	588	7,368	2,051	604	10,023
1951-52	3,492	1,864	583	5,939	1,751	843	8,553
1952-53	[b]						
1953-54							
1954-55	3,218	1,866	739	5,823	1,467	779	8,069
1955-56	3,706	1,804	815	6,325	1,365	769	8,459
1956-57	3,186	1,465	776	5,427	1,323	767	7,517
1957-58	3,590	1,501	808	5,899	1,332	845	8,076
1958-59	5,028	1,988	745	7,761	1,384	842	9,987
1959-60	5,558	2,253	864	8,675	1,368	841	10,884
1960-61	4,352	1,603	721	6,676	1,250	705	8,631
1961-62	4,684	1,422	463	6,569	1,122	901	8,592
1962-63	5,502	1,338	557	7,379	1,400	644	9,423

[a] Beginning September 1.

[b] Blanks indicate no data available per class.

(Continued on next page.)

TABLE 4--continued.

Sources:

Col. 1:	U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964, 31p. Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division.
Col. 2:	Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division.
Cols. 3, 5, and 6:	California Federal-State Market News Service, Dry Beans: California Market Summary (Sacramento, annual issues).

TABLE 5

Total Exports of Dry Edible Beans by Varieties, Cleaned Basis 1949-50 through 1963-64

Year[a]	Navy	Great northern	Small white	Large lima	Small lima
	1,000 hundredweight				
1949-50	105	167	0	50	0
1950-51	460	840	0	25	420
1951-52	701	690	40	34	161
1952-53	250	577	0	19	811
1953-54	716	335	0	80	70
1954-55	58	294	b/	200	100
1955-56	682	193		47	161
1956-57	1,437	266		42	96
1957-58	31	129		27	139
1958-59	1,046	412		40	22
1959-60	1,455	629		20	94
1960-61	665	69		12	37
1961-62	1,432	44		22	9
1962-63	2,219	250		205	187
1963-64	1,938	726		74	41

a/ Beginning September 1.

b/ Blanks indicate no data available.

Sources:

1949-50 through 1953-54:	Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division.
1954-55 through 1963-64:	U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964.

TABLE 6

Quantities of Dry Edible Beans by Varieties for Export Disposition from Credit Commodity Corporation Stocks, Cleaned Basis, 1950-51 through 1963-64

Year a/	Navy		Great northern		Small white		Large lima		Small lima	
	Sale	Donation	Sale	Donation	Sale	Donation	Sale	Donation	Sale	Donation
	1,000 hundredweight									
1950-51	01	44	351	511	0	0	0	420	2	0
1951-52	436	0	689	0	40	0	0	0	161	0
1952-53	b/									
1953-54										
1954-55	6	0	21	20	0	0	191	28	104	0
1955-56	62	0	78	3	0	0	0	0	273	22
1956-57	1,539	2	316	1	0	0	3	7	45	2
1957-58	0	1	37	0	0	0	39	0	51	0
1958-59	8	0	0	44	0	0	57	0	0	0
1959-60	0	0	0	0	0	0	0	0	0	0
1960-61	0	127	0	0	0	0	0	0	0	0
1961-62	223	828	25	0	0	0	0	0	0	0
1962-63										
1963-64										

a/ Beginning September 1.

b/ Blanks indicate figures not available by variety. Total figures for dry edible beans are:

	Sale	Donation
1952-53	22	1
1953-54	9	3
1962-63	669	455
1963-64	19	77

Source: Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division.

1950-51; yet in that year, according to California sources, CCC starting stocks of large limas were only 204,000 hundredweight while actual takeover was zero.[1] Because these export data are so poor, it is difficult to derive anything conclusive from them.

Export sales and donations are only a part of governmental intervention in the production and marketing of dry edible beans. As previously stated, all varieties except blackeyes have been grown and marketed under a price-support program--at least, since World War II. Over the years, prices have been changed several times. They were adjusted downward after the war to reach a low in 1950-51 and then were raised during the Korean War episode. Later, when large takeovers occurred, prices were revised further downward to reach their lowest level in 1959-60. A general increase occurred again in 1961-62. Changes in support prices generally were applied to all categories in about the same proportion. A single exception occurred during the Korean conflict when the support price for small lima beans was not raised.

The practice of changing support prices nearly in the same proportion for all varieties is indicative of a prevailing rigid attitude and a failure to take into account changing demand conditions for each variety. This is only part of the picture, however. Grains compete with beans for the same land. Between the period 1948-1951 and 1959-1963, for example, corn yields rose 50 percent in Michigan while corn prices dropped 30 percent. During the same period, on the other hand, navy bean yields increased 35 percent, but the support price declined only 10 percent. Since corn is a primary competitor to navy beans, this development was not unfavorable for navy beans. But the situation was much less favorable for California beans. Grain sorghum yields rose 75 percent with a price drop of 26 percent, and barley yields rose 55 percent with a price drop of 16 percent. At the same time, yield increases were 0 percent for large limas and 16 percent for small limas, while support prices for small limas, large limas, and small whites declined by 33 percent, 5 percent, and 8 percent, respectively.

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[1] Takeover means CCC acquisitions as a consequence of a price-support program.

Support prices are summarized in Table 7 and CCC acquisitions in Table 8. During the last 10 years, considering only the white varieties and large and small limas, significant takeovers have occurred only for navy beans. Since the end of the 1950's, CCC acquisitions of navy beans have amounted to about one-fourth of their production.

An Econometric Model of the Supply Response of Dry Edible Beans--White Classes, Large and Small Limas, and Blackeyes

In this section, an economic and statistical model will be developed to represent the supply response of the sector under study. This model will serve as a basis for quantitative estimation and is intended to yield structural estimates that will be useful for gauging consequences of alternative courses of action.

Every econometric model draws its information from three sources: the existing body of economic knowledge, the particular characteristics of the sector in question, and the statistical techniques available. Accordingly, we shall construct first an economic model based on economic principles and empirical knowledge and then a statistical model which transforms and conditions the economic model to make it feasible for stochastic estimation.

The Economic Models

The supply function is derived from the equilibrium position of the firm, subject to the production function constraint. It can be written as:

TABLE 7

Support Prices of Dry Edible Beans by Varieties, Cleaned Basis 1947-48 through 1963-64

Year[a/]	Navy	Great northern	Small white	Large lima	Small lima
	dollars per hundredweight				
1947-48	7.58	7.23-7.33	7.78	9.43	7.83
1948-49	8.07	7.72-7.82	8.27	9.92	8.52
1949-50	7.00	6.65-6.75	7.20	8.85	7.25
1950-51	6.42-6.92	6.16-6.63	6.97	8.62	7.02
1951-52	7.34-7.84	7.08-7.55	7.89	10.04	6.44
1952-53	8.15-8.65	7.92-8.40	8.30	11.80	6.45
1953-54	8.20-8.70	8.00-8.40	8.35	11.80	6.45
1954-55	7.66-8.16	7.38-7.88	7.81	10.81	6.06
1955-56	6.68-7.18	6.33-6.83	6.76	9.76	5.01
1956-57	6.63-7.13	6.28-6.78	6.71	9.71	4.96
1957-58	6.54-7.04	6.19-6.69	6.92	9.67	4.92
1958-59	6.42-6.92	6.07-6.57	6.80	9.55	4.80
1959-60	5.68-6.18	5.33-5.83	6.06	8.81	4.21
1960-61	5.71-6.21	4.36-5.86	6.09	8.73- 8.88	4.24
1961-62	6.40-6.90	6.40-6.90	7.21	9.93-10.08	5.28
1962-63	6.40-6.90	6.52-7.02	7.33	10.05-10.20	5.40
1963-64	6.40-6.90	6.52-7.02	7.33	10.05-10.20	5.40

[a/] Beginning September 1.

Sources:

U. S. Department of Agriculture, Agricultural Statistics, annual issues.

U. S. Economic Research Service, The Fruit Situation, quarterly issues.

Idem, The Vegetable Situation, quarterly issues.

TABLE 8

Credit Commodity Corporation Acquisitions of Dry Edible Beans by Varieties
Cleaned Basis, 1948-49 through 1963-64

Year[a]	Navy[b]	Small white	Large lima	Small lima
	1	2	3	4
	1,000 hundredweight			
1948-49	666	253	0	384
1949-50	1,845	0	240	563
1950-51	10	0	0	296
1951-52	1,130	194	0	318
1952-53	385	0	350	0
1953-54	230	[c]		
1954-55	0	0	242	321
1955-56	622	0	17	0
1956-57	1,746	0	105	176
1957-58	32	0	23	0
1958-59	9	0	58	5
1959-60	178	2	0	0
1960-61	1,834	0	0	0
1961-62	1,612	0	0	0
1962-63	964	0	0	0
1963-64	1,012	0	16	0

(Continued on next page.)

TABLE 8--continued.

a/ Beginning September 1.

b/ There have also been direct purchases by the government during 1960-61, 1961-62, and 1963-64 of the following quantities: 244,000 hundredweight, 730,000 hundredweight, and 436,000 hundredweight, respectively.

c/ Blanks indicate no data available.

Sources:

Col. 1: For 1948-49 through 1952-53, Dale E. Hathaway, The Effects of the Price Support Program on the Dry Bean Industry in Michigan, Michigan Agricultural Experiment Station Technical Bulletin 250 (East Lansing, 1955), 71p.

For 1953-54 through 1957-58, U. S. Department of Agriculture, Federal Extension Service, Statistical Summary: Dry Edible Beans and Dry Field Peas, October, 1964, 31p.

For 1958-59 through 1963-64, personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division.

Cols. 2, 3, and 4: For 1948-49 through 1963-64, California Federal-State Market News Service, Dry Beans: California Market Summary (Sacramento, annual issues).

$$\frac{r_i}{p} = f(n_1, n_2, \ldots, n_k) \quad i = 1, \ldots, k$$

which says that the real factor cost of the *i*th factor must equal the marginal productivity of the *i*th factor, and

$$x = g(n_1, n_2, \ldots, n_k)$$

which expresses output as a certain function of the k inputs. The k marginal productivity functions also can be written as

$$n_i = k_i\left(\frac{r_1}{p}, \frac{r_2}{p}, \ldots, \frac{r_k}{p}\right)$$

which expresses each input as a function of the real factor costs. It is assumed that the marginal productivity functions are well behaved so that the inversion may be performed. Substituting each of the k_i functions into the production function gives us

$$\begin{aligned} x &= g(k_1, k_2, \ldots, k_r) \\ &= s\left(\frac{r_1}{p}, \frac{r_2}{p}, \ldots, \frac{r_k}{p}\right). \end{aligned}$$

Quite often, supply functions involve only price of the output, costs being deleted on the assumption that they are constant. Introduction of prices of competing products (for the same resources) introduces costs through the "opportunity cost" concept; and furthermore, the expression of these prices in logarithms is another way of formulating ratios.

Although these formulations are basic to the supply functions, they provide no way for distinguishing between short-run and long-run response nor do they provide any information as to the most relevant prices to be used. As to the latter issue, it is assumed that expected prices are the most relevant, and lagged prices are then used as a somewhat naive price expectation model.

With respect to short-run and long-run response, the Nerlove model may be applied.[1] The reasoning goes as follows: Postulate that price and opportunity costs as of t-1 would lead to an equilibrium acreage but that this longer run equilibrium acreage is not necessarily reached in period t. Thus:

$$\text{acreage } x_1 = \alpha_0 + \alpha_1 \log \text{price } x_{1t-1} + \alpha_2 \log \text{price } x_{2t-1} + \ldots$$
$$+ \alpha_k \log \text{price } x_{k-1}$$

where acreage x_1 would be the final long-run acreage of x_1 after full adjustment. Writing x_1 for acreage and $\overline{x}_1$ for long-run equilibrium acreage, we can assume that this year's acreage will go part of the way toward the fully adjusted acreage; and therefore:

$$x_{1t} - x_{1t-1} = \delta\ (\overline{x}_1 - x_{1t-1})$$

where $0 < \delta < 1$.

This leads to:

$$\overline{x}_1 = \frac{1}{\delta} x_{1t} + (1 - \frac{1}{\delta})\ x_{1t-1}.$$

Consequently,

$$\frac{1}{\delta} x_{1t} + (1 - \frac{1}{\delta})\ x_{1t-1} = \alpha_0 + \alpha_1 \log \text{price } x_{1t-1} + \ldots + \alpha_k \log \text{price } x_{kt-1}$$

or

$$x_{1t} + \alpha_0\delta + (1 - \delta)\ x_{1t-1} + \alpha_1\delta \log \text{price } x_{1t-1} + \ldots + \alpha_k\delta \log \text{price } x_{kt-1}.$$

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[1] Marc Nerlove, "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations," *Journal of Farm Economics*, Vol. 40, No. 2 (May, 1958), pp. 301-311.

This is the general supply model to be tested. The α_i can easily be separated from the $\delta\alpha_i$ because of the estimate obtained for $(1-\delta)$. They are estimates of the long-run supply responses. The $\delta\alpha_i$ can be interpreted as short-run supply price responses.

The exact composition of the variables used in every supply function may now be discussed. According to D. E. Hathaway, wheat and corn are the closest competitors to navy beans.[1] In this analysis, wheat prices were excluded from the supply function mainly because of the rigid wheat allotment program in effect during the greatest part of the period under consideration. While navy beans were subjected to an acreage allotment program during 1950-51, wheat acreage also was restricted in that year. Wheat acreage allotments were again established in 1954-55 and were continued for the rest of the period under observation at about the same magnitude. Under the assumption of filled wheat acreage quotas (which actually occurred), wheat prices could thus exert an influence only in the years 1948-1950 and 1952-1954. Therefore, rather than include wheat prices and a dummy variable, it was decided to treat corn as the sole competitor to navy beans. Even then, the years 1950-51 and 1951-52 had to be deleted because of a navy bean acreage allotment in 1950-51 and the subsequent use of this value in explaining navy bean acreage in 1951-52.

In 1954-55, although navy bean acreage was not controlled, its magnitude very likely was partly determined by new controls on wheat acreage; therefore, that year was also deleted from the analysis. As a result, it was not possible to capture explicitly the shift from before to after 1954-55. However, this shift was included implicitly through the use of the navy bean acreage of

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[1] Hathaway, op. cit., p. 21.

1954-55 to explain navy bean acreage in 1955-56 and the constant magnitude of wheat acreage allotments during subsequent years of the observation period.

A choice also had to be made between the use of price received per bushel of corn and return per acre of corn, thus including yields of corn. The same problem arose with respect to the supply relationships for the other bean varieties. Such a choice could, perhaps, be made on the following basis, although the argument may not be very persuasive to many readers. If yields for a particular variety of beans and its competing feed grains showed a similar development in magnitude, the price per unit might be used. In the opposite case, returns per acre could be used. Navy beans would fall in the first group and California-grown beans in the latter.[1/] In any event, both specifications of this variable were used, and the results dictated the choice.

Sorghum grains and barley are considered nonbean competing crops for lima beans, small whites, and blackeyes (all exclusively grown in California). Prices and/or returns per acre were arbitrarily aggregated on a 50-50 basis; that is, a simple arithmetic mean of average returns per acre and/or prices was used.

Besides feed grains, California beans also compete with each other for the land. Consequently, an index of competing bean prices was constructed for every class of California beans included in the study. These indexes were derived as follows: California was divided into four regions--southern region, coastal region, San Joaquin Valley, and Sacramento Valley. Then, as presented in Table 9, a two-way cross-classification table was constructed using average production data over the period 1959-1963. The use of production data rather than acreage data incorporates the differential yield factor.

[1/] *Supra*, pp. 12-13.

TABLE 9

Regional Distribution of the Production of Dry Edible Beans by Major Varieties
California, 1959-1963

Variety	Southern		Coastal		San Joaquin Valley		Sacramento Valley		Total
	1[a]	2[b]	1	2	1	2	1	2	
Large lima	.65	.79	.06	.08	.29	.19	.00	.00	1.00
Small lima	.01	.01	.00	.00	.48	.19	.51	.39	1.00
Blackeye	.12	.13	.00	.00	.83	.51	.05	.06	1.00
Pink	.02	.01	.03	.02	.01	.00	.94	.47	1.00
Small white	.08	.06	.92	.90	.00	.00	.00	.00	1.00
West red kidney	.00	.00	.01	.00	.71	.11	.28	.08	1.00
		1.00		1.00		1.00		1.00	

a/ Figures under 1, read horizontally, give distribution over the different regions per variety.

b/ Figures under 2, read vertically, give the composition per region.

Source: California Federal-State Market News Service, Dry Beans: California Market Summary (Sacramento, annual issues).

Now to compute, let us say, the large lima bean competitive price index, we give all other varieties weights equal to their importance in a given region; and the regions are then weighted in accordance to their importance for large limas. Thus, the large lima bean competitive price index = .65 (.01 price small limas + .13 price blackeyes + .01 price pinks + .06 price small whites + .00 price west red kidney) + .06 (.00 price small limas + .00 price blackeyes + .02 price pinks + .90 price small whites + .00 price west red kidney) + .29 (.19 price small limas + .51 price blackeyes + .00 price pinks + .00 price small whites + .11 price west red kidney) + .00 (.39 price small limas + .06 price blackeyes + .47 price pinks + .00 price small whites + .08 price west red kidney). Therefore, gathering terms with respect to varieties, we have: (.65) (.01) + (.29) (.19) price small limas + (.65) (.13) + (.29) (.51) price blackeyes + (.65) (.01) + (.06) (.02) price pinks + (.65) (.06) + (.06) (.90) price small whites + (.29) (.11) price west red kidney = the large lima competitive bean price index. Working out further, the index = .06 price small limas + .23 price blackeyes + .11 price pinks + .09 price small whites + .03 price west red kidney. In order for these weights to add up to 1.00, they were all multiplied by $\frac{1}{.52}$. Similar competing bean price indexes have been computed for small limas, blackeyes, and small whites.

Because acreages for small whites, great northerns, and blackeyes were not available for the entire period, data for production were used instead. To get at an estimate of the long-run supply reaction, prices of small whites, great northerns, and blackeyes lagged one and two periods were introduced in place of lagged production, thus avoiding the complicating factor of yields. Time was introduced in the supply equations for these three classes in order to capture trends in yields.

Great northerns are predominantly grown in Idaho, Nebraska, and Wyoming and compete for acreage with pinto beans as well as grains such as barley, oats, corn, and sorghum. The relevant farm state prices and/or returns per acre of these feed grains were aggregated into one series with weights representing both the importance of the feed grains in each state and the importance of the states in the production of great northerns.

For the same reasons as those given for navy beans, 1950-51 and 1951-52 were deleted in analyzing the supply response for large and small limas, small whites, and great northerns. The year 1954-55 was not deleted from the analysis for these varieties, however, because they seemed little affected by the acreage restrictions on wheat. No years were deleted from the analysis for blackeyes because blackeyes, even in 1950-51, were not subject to acreage allotments.

The economic models of supply response can now be formalized as follows:[1]

$y_{1t} = f\ (y_{1t-1}, \log z_{1t-1}, \log z_{2t-1})$

$y_{2t} = f\ (y_{2t-1}, \log z_{3t-1}, \log z_{4t-1}, \log z_{5t-1})$

$y_{3t} = f\ (y_{3t-1}, \log z_{5t-1}, \log z_{6t-1}, \log z_{7t-1})$

$y_{4t} = f\ (\log z_{5t-1}, \log z_{8t-1}, \log z_{8t-2}, \log z_{9t-1}, t)$

$y_{5t} = f\ (\log z_{5t-1}, \log z_{10t-1}, \log z_{10t-2}, \log z_{11t-1}, t)$

$y_{6t} = f\ (\log z_{12t-1}, \log z_{12t-2}, \log z_{13t-1}, \log z_{14t-1}, t)$

where

y_{1t} = thousand acres planted to navy beans in t

y_{2t} = thousand acres planted to small limas in t

y_{3t} = thousand acres planted to large limas in t

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[1] Only those variables are listed and their contents defined that are used in the final presentation.

y_{4t} = thousand hundredweight produced of small whites in t

y_{5t} = thousand hundredweight produced of blackeyes in t

y_{6t} = thousand hundredweight produced of great northerns in t

z_{1t} = average price of navy beans per hundredweight paid to producer in t

z_{2t} = average price of corn per bushel paid to Michigan farmer in t

z_{3t} = average price of small limas per hundredweight paid to producer in t

z_{4t} = average price of competing beans (to small limas) per hundredweight paid to producer in t

z_{5t} = average gross income of barley and sorghum per acre to California producer in t

z_{6t} = average price of large limas per hundredweight paid to producer in t

z_{7t} = average price of competing beans (to large limas) per hundredweight paid to producer in t

z_{8t} = average price of small whites per hundredweight paid to producer in t

z_{9t} = average price of competing beans (to small whites) per hundredweight paid to producer in t

z_{10t} = average price of blackeyes per hundredweight paid to producer in t

z_{11t} = average support of large limas per hundredweight paid to producer in t

z_{12t} = average support of small limas per hundredweight paid to producer in t

z_{13t} = average price of great northerns per hundredweight paid to producer in t

z_{14t} = average price of feed grains per bushel to producers in Idaho, Nebraska, and Wyoming in t

z_{15t} = average support price of great northerns per hundredweight paid to producer in t

and

t = time (1, ...).

When market prices have been at or near established support prices in recent periods, there is a priori reason for current support prices to be more relevant for planning than lagged market prices. This a priori expectation has been contradicted in the past. Hathaway tested the hypothesis that after the price-support program was inaugurated for navy beans, farmers would respond to the price announced in advance as the price-support level. But he found no statistical evidence to substantiate this hypothesis. It is probable that only drastic differences between last year's price and the announced support price would prove to be relevant. In any event, the hypothesis that support prices are relevant to the acreage or supply in any given year will be tested.

Hathaway included the abandonment of acreage in t-1 in the acreage function for navy beans, reasoning that abandonment could be closely related to the risk and asset position of farmers in determining acreage planted.1/ Abandonment proved then to be relevant in determining acreage planted. Whether this holds true for the more recent period here under investigation will likewise be tested.

The data used in the estimation process have been grouped in Tables 10 and 11.

The Stochastic Models

Before meaningful inferences can be drawn from the models constructed in the preceding pages, they have to be cast in the proper stochastic framework. For every model presented, it is assumed that each observation, y_{it}, is a linear function of the absolute or logarithmic value of the observations in

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1/ Hathaway, *op. cit.*, p. 20.

TABLE 10

Dependent and Lagged Endogenous Variables: Data Used in Supply Response Models for Some Categories of Dry Edible Beans, 1947-48 through 1963-64

Marketing year	y_{1t}	y_{2t}	y_{3t}	y_{4t}	y_{5t}	y_{6t}
	1	2	3	4	5	6
1947-48	494	79	70	[a]		
1948-49	514	75	70	734	1,087	4,091
1949-50	529	83	92	625	318	3,165
1950-51					611	
1951-52	392	52	68		918	
1952-53	349	28	81	540	647	1,872
1953-54	384	36	68	560	767	1,707
1954-55	492	43	73	698	703	1,956
1955-56	522	24	72	779	962	1,949
1956-57	517	30	60	652	654	1,809
1957-58	517	17	61	666	793	1,501
1958-59	548	22	66	723	919	2,035
1959-60	548	24	60	819	841	2,256
1960-61	532	25	49	546	570	1,572
1961-62	548	28	47	402	966	1,678
1962-63	581	30	53	513	648	1,469
1963-64	581	30	48	561	770	2,282

(Continued on next page.)

TABLE 10--continued.

a/ Blanks indicate data deleted from this analysis.

Sources:

Cols. 1, 2, 3, and 6: U. S. Department of Agriculture, *Agricultural Statistics*, annual issues.

Cols. 4 and 5: California Federal-State Market News Service, *Dry Beans: California Market Summary* (Sacramento, annual issues).

TABLE 11

Independent Variables: Data Used in the Supply Response Models for Some Categories of Dry Edible Beans[a]
1947-48 through 1963-64

Marketing year	z_{1t}	z_{2t}	z_{3t}	z_{4t}	z_{5t}	z_{6t}	z_{7t}	z_{8t}	z_{9t}	z_{10t}	z_{11t}	z_{12t}	z_{13t}	z_{14t}	z_{15t}	t
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1947-48	13.29	2.21	10.14	16.95	49.32	23.86	15.46	15.23	22.33	17.76	9.92	[b]	10.81	1.17		1
1948-49	8.10	1.30	8.48	9.29	41.57	17.78	7.75	8.83	16.00	6.29	8.85	8.52	7.76	1.05	7.82	2
1949-50										12.46		7.25			6.75	
1950-51										14.39						
1951-52	7.83	1.69	6.48	9.73	49.03	11.51	8.76	8.12	10.98	9.30	11.80		7.93	1.30		5
1952-53	8.81	1.50	7.42	11.55	48.50	11.47	10.90	9.03	11.44	12.60	11.80	6.45	8.48	1.21	8.40	6
1953-54			7.30	9.35	47.32	11.66	8.89	10.21	11.15	8.63	10.81	6.45	8.61	1.19	8.40	7
1954-55	10.34	1.35	6.19	10.26	48.42	11.08	10.09	11.48	10.72	11.36	9.76	6.06	8.37	1.10	7.88	8
1955-56	7.34	1.25	7.58	7.83	43.49	10.56	7.47	8.24	9.90	6.51	9.71	5.01	6.79	1.08	6.83	9
1956-57	7.39	1.23	5.82	8.62	45.84	10.70	7.73	8.08	10.17	8.02	9.67	4.96	6.77	.93	6.78	10
1957-58	9.18	1.48	7.60	8.74	42.99	11.25	8.34	9.64	10.75	7.72	9.55	4.92	9.40	.93	6.69	11
1958-59	7.31	1.09	7.86	8.10	43.65	10.95	7.76	9.18	11.10	7.33	8.81	4.80	7.49	.91	6.57	12
1959-60	6.29	1.04	8.10	10.57	44.28	12.04	8.86	7.47	11.73	7.28	8.89	4.21	7.13	.87	5.83	13
1960-61	6.53	.99	11.00	11.95	50.09	16.93	10.77	9.08	16.05	10.86	10.08	4.24	7.68	.94	5.86	14
1961-62	6.85	.99	8.12	8.90	55.69	15.13	8.17	10.36	13.84	7.15	10.20	5.28	7.16	.95	6.90	15
1962-63	6.90	1.05	8.42	9.24	58.73	11.30	8.91	9.45	10.87	8.75	10.20	5.40	8.90	.94	7.02	16
1963-64												5.40			7.02	

[a] Prices for pea and great northern beans include brokerage, cleaning, and handling charges; prices for California varieties are shipping prices (dealers' quotations).

[b] Blanks indicate data deleted from this analysis.

Sources:

Cols. 1, 2, 5, 12, 14, and 15:	U. S. Department of Agriculture, Agricultural Statistics, annual issues.
Cols. 3, 4, 6, 7, 8, 9, 10, 11, 13, and 16:	California Federal-State Market News Service, Dry Beans: California Market Summary (Sacramento, annual issues).

the relevant time period on the right-hand side of the equality sign and of a disturbance term e_t. Furthermore, for every model:

$Ee = 0$ (or each disturbance has zero expectation)

$Eee' = \sigma^2 I$ ($Ee^2_t = \sigma^2$ for all t, implying a constant variance and $Ee_s e_t = 0$ for all $s \neq t$ which states that the disturbances are temporally uncorrelated)

$$\left.\begin{array}{l} E\,(e|Z) = 0 \\ E\,(e|t) = 0 \end{array}\right\}$$ (the exogenous variables are distributed independently of the disturbances)

and

$E\,(e|y_{t-1}) = 0$ for $e = e_t, e_{t+1}, \ldots, e_T$ (or the lagged endogenous variables are distributed independently of the contemporaneous and succeeding disturbances).

It has been shown that when the above conditions hold, ordinary least-squares estimation of the models results in minimum variance and asymptotically unbiased estimates of the parameters.[1]

The Results

Thus far, the analysis has provided a theoretical and statistical framework for the empirical work to be carried out. Now, the results of confronting the models with the data via estimation procedures can be presented. The resulting estimates will then be examined to determine their agreement or disagreement with respect to economic theory and circumstantial evidence. Coefficients are given in four significant digits. The estimated standard error of each coefficient is shown beneath in parentheses. The standard errors of estimate on the equation are denoted by S. The Durbin-Watson statistic for measuring serial correlation in disturbances is denoted by d. The coefficient of multiple determination is shown as R^2. The results are:

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[1] Arthur Stanley Goldberger, Econometric Theory (New York: John Wiley & Sons, 1964), pp. 162-170 and pp. 272-282.

Acreage equation for navy beans:

$$y_{1t} = -290.0100 + \underset{(.0903)}{.8658}\, y_{1t-1} + \underset{(45.1428)}{197.0946} \log z_{1t-1} - \underset{(46.4770)}{171.5520} \log z_{2t-1} + u_{1t}$$

$R^2 = .96$ $\quad$ $S = 14.78$ $\quad$ $d = 2.77$ (i)[1]

Acreage equation for small limas:

$$y_{2t} = 68.6638 + \underset{(.1955)}{.5411}\, y_{2t-1} + \underset{(12.9815)}{46.1615} \log z_{3t-1} - \underset{(13.9629)}{24.3715} \log z_{4t-1}$$

$$- \underset{(21.1708)}{43.0930} \log z_{5t-1} + \underset{(19.7581)}{43.5291} \log z_{12t} + u_{2t}$$

$R^2 = .92$ $\quad$ $S = 6.75$ $\quad$ $d = 2.70$ (i)

Supply equation for large limas:

$$y_{3t} = -77.0513 + \underset{(.2523)}{.7115}\, y_{3t-1} - \underset{(378.8694)}{866.2656} \log z_{5t-1} + \underset{(178.8741)}{663.9568} \log z_{6t-1}$$

$$- \underset{(194.2793)}{403.6242} \log z_{7t-1} + \underset{(486.7335)}{1{,}274.3648} \log z_{11t} + u_{3t}$$

$R^2 = .80$ $\quad$ $S = 111.26$ $\quad$ $d = 2.23$ (i)

Supply equation for small whites:

$$y_{4t} = 2{,}739.6010 - \underset{(157.0015)}{729.3139} \log z_{5t-1} + \underset{(106.1815)}{647.6832} \log z_{8t-1}$$

$$+ \underset{(78.3411)}{119.0698} \log z_{8t-2} - \underset{(81.8013)}{406.6399} \log z_{9t-1} + u_{4t}$$

$R^2 = .86$ $\quad$ $S = 49.95$ $\quad$ $d = 2.31$ (i)

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[1] Where the symbol (i) follows the statistic d, the Durbin-Watson test for serial correlation of the error term was inconclusive; (n) indicates that the test showed no serial correlation.

Supply equation for blackeyes:

$$y_{5t} = 674.5211 + \underset{(124.0556)}{561.5261} \log z_{10t-1} + \underset{(7.9103)}{21.2570t} + u_{5t}$$

$$R^2 = .65 \qquad S = 126.6866 \qquad d = 1.28 \text{ (i)}$$

Supply equation for great northerns:

$$y_{6t} = -11.3108 + \underset{(.7149)}{2.4991} \log z_{12t-1} + \underset{(.7524)}{2.6831} \log z_{12t-2}$$

$$- \underset{(1.6106)}{3.6444} \log z_{14t-1} + \underset{(1.6333)}{1.7082} \log z_{15t} - \underset{(.0344)}{.0669t} + u_{6t}$$

$$R^2 = .90 \qquad S = .27 \qquad d = 1.83 \text{ (i)}$$

The reader will have noticed that these equations are slightly different from the initial theoretical set. This results from (1) the incorporation of support prices in the acreage equations of small and large limas and great northerns where there was statistical indication that they were relevant; (2) the deletion of competing bean prices, feed grain prices, and own price lagged two periods in the supply equation for blackeyes; and (3) the deletion of prices of pinto beans in the supply equation for great northerns where statistical evidence was to the contrary. In the case of large limas, acreage was replaced by production because use of the former resulted in a negative coefficient of adjustment (δ). Production in t-1 was allowed in this equation because of relatively stable yields.

With respect to the most relevant specification of the opportunity cost of feed grains, returns per acre gave better results for California-grown beans while price per unit was the better specification for the other varieties.

The results obtained are very satisfactory. All structural coefficients exhibit signs consistent with economic theory. The standard errors of the coefficients in general are small relative to the coefficients themselves. There is no definite indication of serial correlation in any of the models. The sizes of the elasticities that can be derived from the structural coefficients are "very acceptable." These elasticities are summarized in Table 12.

The elasticities suggest that although the long-run reaction of production to own price is in the same neighborhood for most classes, short-run response of supply to price is considerably higher for California beans than for navy beans. A similar distinction can be made with respect to prices of competing feed grains. The long-run reaction appears to be substantially the same for all varieties; but in the short run, California classes again react much more noticeably than navy beans to changed feed grain prices. For California, it also appears that in production feed grains are closer substitutes to a particular bean class than other classes of beans. On the other hand, there was no apparent effect on blackeye production of changed bean and/or feed grain prices.

Although Hathaway does not explicitly report a supply elasticity for navy beans, an elasticity of around +.35 can be derived from his numerical illustrations.[1/] His acreage function was not intended to yield any estimate of the long-run elasticity. This led him to conclude: "On the other hand, acreage planted to dry beans in Michigan appears to be quite inelastic in response to price, so that increasing or decreasing the level of price supports is not likely to result in substantial acreage changes."[2/] On grounds of the long-run estimate of supply response obtained in this analysis, his conclusion is likely to be incorrect.

[1/] Hathaway, op. cit., pp. 22-23.

[2/] Ibid., p. 3.

TABLE 12

Elasticities of the Means Derived from Estimates of the Parameters of Supply Relationships for Some Categories of Dry Edible Beans

Elasticities of / with respect to	Acreage						Production					
	Navy		Large lima		Small lima		Great northern		Small white		Blackeye	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
Own price	+.39	+2.90	+.64	+2.22	+1.26	+2.75	+1.21	+2.52	+1.03	+1.22	+.74	
Price of competing beans			-.39	-1.35	- .67	-1.46			- .65			
Price of corn	-.34	-2.53										
Price of feedgrains							-1.77					
Income from barley and Sorghum			-.83	-2.88	- .67	-1.46			-1.16			

Source: Elasticities derived from the estimated supply relationships.

Besides Hathaway's, only one other related manuscript, including quantitative work, is known to the author. R. B. How estimated a supply equation for blackeyes.[1] Collecting the variables which seemed to determine production, he presented the following structure (estimation occurred using 1948-1962 data):

$$\begin{aligned} &\text{production of blackeyes per capita in } t = .240 \\ &\quad + \underset{(.265)}{.499}\ (\text{production of blackeyes per capita in } t-1) \\ &\quad + \underset{(.0083)}{.0136}\ (\text{price in } t-1) - \underset{(.650)}{1.843}\ (\text{carryover from } t-1) + u_t \\ &\quad R^2 = .78 \qquad d = 1.36 \end{aligned}$$

Apart from possible influences of yield variations and the minimization of the role of price through the inclusion of carryover stocks (large carryover would logically go together with low prices in t-1 and vice versa), this structure is of the Nerlove type. From the equation, a short-run supply elasticity of +.24 and a long-run elasticity of +.48 were obtained.

Yield Functions

It was intended to construct and estimate yield functions for the various categories considered in this study. Practical results were totally disappointing; and therefore, only the general economic model is presented.

Weather is undoubtedly the most important variable influencing yields in any given year. Improvements in varieties and cultural practices could be represented by a time variable. Two other variables which might be relevant are acreage and expected price. It seems reasonable to assume that as acreage increases land is taken into production that is less and less suitable for the particular crop in question. When price expectations are favorable, farmers may try to increase yields through increased application of fertilizer and better performed cultural practices. Because no weather indexes were available, yields were assumed to depend on time, acreage, and price in t-1 and/or support price t.

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[1] Draft copy, dated November 23, 1964, of R. B. How, "Factors Affecting Prices of Dry Beans," Prepared for presentation to the Seventh Dry Bean Research Conference, Ithaca, New York, December 3, 1964, 28p.

Concluding Note

Although no detailed analysis of the residuals was performed, the supply equations were also estimated in their linear form. The fit, however, was not as good as the one obtained from the form presented.

Price-Demand Structure of Dry Edible Beans--White Classes Large and Small Limas, and Blackeyes

The development of this section is analogous to the preceding one. Its purpose also is to arrive at estimates of the underlying parameter structure but this time of demand and price response. Knowledge of the parameter structures underlying supply, demand, and price response will make it possible then to evaluate alternative price-support programs. Consequently, an economic and statistical model will be formulated to be confronted with the data in the estimation process.

The Economic Models

In constructing the models, the first assumption made (supported by statistical evidence in some preliminary work) was that the price-demand structure for navy beans, small whites, or great northerns is not significantly dependent upon the price-demand structure for lima beans and vice versa. Allowance was made, however, for the possibility that price-demand relationships of the first three could be determined simultaneously. Allowance was made also for the possibility that navy bean prices influence prices of blackeyes. However, since blackeyes are unlikely to have a significant influence on prices of navy beans, great northerns, and small whites, it was assumed that no serious error would be committed by omitting the price of blackeyes from the equations representing the price-demand structure for these varieties. Consequently, three submodels could be constructed--one for the white classes, one for lima beans (both large and small), and one for blackeyes.

An important characteristic of the price-demand structures of these classes of beans (except blackeyes) is the presence of a support price and the need to consider any consequent CCC acquisitions. In some earlier cases, this characteristic was accommodated through the construction of a relationship explaining CCC acquisitions.[1] The logic was as follows: government takeover of a commodity under price support is a function of the difference between the free-market price and the support price. Because the free-market price cannot be observed when takeover actually occurs, it is represented by factors determining the free-market price; namely, supply, competing supplies, income, and population. Consequently, CCC acquisitions are postulated to be determined by supplies of the own commodity, competing supplies, income, population, and possibly other demand shifters plus the support price.

However, this method is correct only when takeover by the government occurs in every period. To illustrate, CCC acquisitions can graphically be represented as a function of the difference between free-market price and the support price as shown in Figure 1. The dots on the diagram represent CCC

1/ Hathaway, *op. cit.*, pp. 42 and 68.

William A. Cromarty, "An Econometric Model for United States Agriculture," *Journal of the American Statistical Association*, Vol. 54, No. 287 (September, 1959), pp. 556-574.

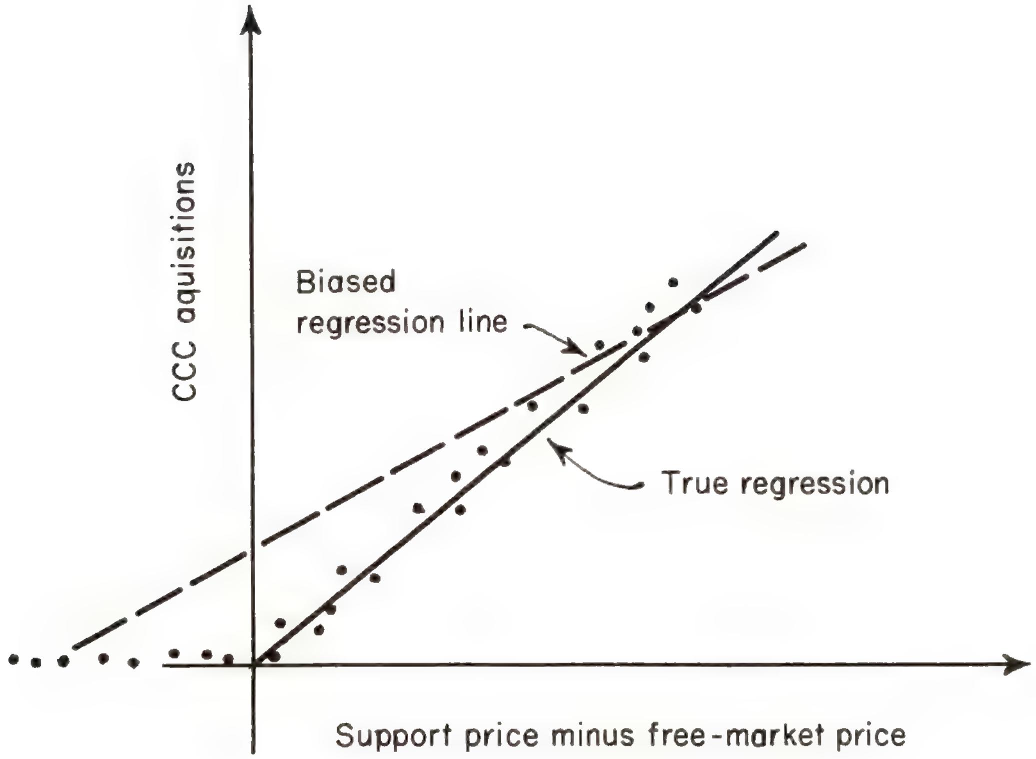

FIGURE 1. CCC Aquisitions as a Function of the Difference Between Support Price and Free-Market Price

acquisitions consistent with differences between support price and free-market price. When the free-market price is higher than the support price, no or insignificant takeovers will result; therefore, a line representing the relationship between the variables on the axes would necessarily have a kink around zero. In fact, only the positive quadrant is relevant for this relationship; and a regression line fitted through all points will automatically be biased, except in the case where the free-market price is always lower than the support price. Furthermore, the use of a dummy variable (0,1) in the relationship discussed in order to avoid bias in the regression line becomes less and less satisfactory as the spread of the negative values (support price minus free-market price) increases.

In this study, CCC acquisitions have been postulated to depend on supplies of the own commodity, competing prices, income, populations, and the difference between actual market price and the support price. With any significant takeover, the last variable will nearly equal zero; with no takeover, this variable should bring the negative takeover resulting from the true regression line back to zero. In other words, the variable, difference between actual market prices and the support prices, is introduced to insure that an unbiased parameter is obtained for the true regression line as represented in the above diagram.

At this point it may be remarked that no provision has been made for government sales from CCC stocks in case the actual market price is significantly above the support price. That is true simply because government sales form an entirely different situation requiring an entirely separate framework. Indeed, whereas actual CCC acquisitions follow from market forces, given a support price, CCC sales are dependent upon: (1) existence of CCC stocks and (2) a decision by the government. Consequently, CCC sales can best be considered exogenous either as a separate variable or added to the supply.

To obtain a complete specification of the price-demand structures, it would be necessary to differentiate between different kinds of quantities demanded. The inadequacy of the available data severely limits our freedom to present much detail. Data on commercial exports of the classes of beans here considered are either absent or unreliable. Data on ending stocks of navy beans and great northerns also are not very reliable. Although these estimates probably would give a rough idea of the magnitude of ending stocks, functions to explain them were not constructed. Data on takeover of great northerns were found to be questionable for some years. Therefore, a typical price equation rather than a demand equation was constructed for this class.

The functions explaining wholesale disappearance (plus ending stocks in the case of navy beans) are based on classical economic theory. Consequently, wholesale disappearance is, in general, a function of the own wholesale price, the wholesale price of the closest competitors, income, and population.

A few qualifications apply with respect to individual classes. To obtain sensible results from a demand equation or price equation, one has to assume that, apart from shifts because of changes in income and in prices of competing products, the quantities demanded in any of the outlets do not differ greatly from one year to the next at the same price, unless one postulates a completely inelastic demand or an abrupt change of structure.

Juxtaposition of commercial demand and price data for navy beans showed the expected inverse movements, except for a few years. The possibility of an abrupt change in structure in those years was rejected in favor of the more reasonable and convenient assumption that an additional factor had played an important role.

The suspected years are 1950-51, 1958-59, 1959-60, 1962-63, and 1963-64 (Table 4). The year 1950-51 undoubtedly was influenced by the Korean War. But what about the others? Estimated exports of navy beans were unusually high for the years 1956-57, 1958-59, 1959-60, 1961-62, 1962-63, and 1963-64 (Table 5). Quantities exported in 1956-57 and 1961-62 seem to have come fully and for two-thirds, respectively, from CCC stocks (Table 6). Sales for export and foreign donations were small in 1958-59, 1959-60, and 1963-64 (Table 6). Although data on these operations are not available per variety for 1962-63, they total more than 1 million hundredweight (Table 6). Even if this amount consisted entirely of navy beans (most probably the case), commercial exports of navy beans in this year would still be very high. U. S. Department of Agriculture publications mention poor bean crops in Europe as a reason for the unusually high commercial exports in these years,[1] but FAO data on European bean crops in these years seem to disprove this.[2] Consequently, all of these occurrences were treated by the introduction of a dummy variable in the demand equation with value 1 for the years 1958-59, 1959-60, 1962-63, and 1963-64 and value 0 for the other years.

With respect to the lima bean sector, the data on consumption and prices suggest that large limas are the primary commodity and that the quantity of small limas demanded depends considerably on the demand for large limas (Table 9). Both varieties seem to be used together as ingredients for another food item. If there were no shifts in the demand function for large limas, the quantities consumed of both varieties would depend upon the relative prices of both. But shifts in the demand function for large limas also determine the demand for small limas. Therefore, the wholesale disappearance of large limas should also appear in the demand equation for small limas.

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[1] U. S. Economic Research Service, The Vegetable Situation, annual years.

[2] Food and Agriculture Organization of the United Nations, Production Yearbook (Rome, annual years).

The price-support program does not apply to blackeyes. Nowhere is there anything mentioned about exports of blackeyes; most likely, they are all consumed domestically. Because the price of navy beans may influence the price of blackeyes considerably and because it may be assumed that the reverse link is sufficiently weak, the price of navy beans as an exogenous variable has been introduced in the demand equation for blackeyes. However, for consistent simulation later on, the model for blackeyes has been considered as a submodel versus the master model representing the white varieties; and therefore, the price of navy beans used was a computed one (resulting from the first round of the two-stage, least-squares estimation procedure).

Inventory demand (where present) has in general been made a function of production (transaction motive) and of the own price and price of the closest competitor (speculative motive). CCC acquisitions have been entered in the stock functions as a corrective factor on production.

The economic models can now be presented as follows:

Price-demand structure for white classes:

$$y_{7t} = f\,(y_{11t}, y_{12t}, y_{10t}, x_{1t}, x_{7t})$$

$$y_{14t} = f\,(y_{10t}, y_{12t}, y_{26t}, x_{1t}, x_{2t}, x_{5t}, x_{7t})$$

$$y_{8t} = f\,(y_{11t}, y_{12t}, x_{1t})$$

$$y_{13t} = f\,(y_{11t}, y_{27t}, x_{1t}, x_{4t}, x_{6t})$$

$$y_{9t} = f\,(y_{11t}, y_{12t}, y_{13t}, x_{4t})$$

$$y_{10t} = f\,(y_{11t}, x_{1t}, x_{3t})$$

where

y_{7t} = commercial wholesale disappearance of navy beans in pounds per capita in t (production + beginning stocks + government domestic sales - government takeover - direct purchases by the government)

y_{8t} = commercial wholesale disappearance of small whites in pounds per capita in t (production + beginning stocks - government takeover - ending stocks)

y_{9t} = commercial ending stocks of small whites in pounds per capita in t

y_{10t} = average wholesale price of great northerns in cents per pound

y_{11t} = average wholesale price of navy beans in cents per pound

y_{12t} = average wholesale price of small whites in cents per pound

y_{13t} = government takeover of small whites in pounds per capita in t

y_{14t} = government takeover of navy beans in pounds per capita in t

y_{26t} = difference between actual market price of navy beans per pound and the support price in t

y_{27t} = difference between actual market price of small whites per pound and the support price in t

x_{1t} = log of disposable income per capita (original series--thousand dollars per capita)

x_{2t} = production + beginning stocks + government domestic sales of navy beans - direct government purchases in pounds per capita in t

x_{3t} = production + beginning stocks of great northerns in pounds per capita in t

x_{4t} = production + beginning stocks of small whites in pounds per capita in t

x_{5t} = support price of navy beans in cents per pound in t

x_{6t} = support price of small whites in cents per pound in t

and

x_{7t} = dummy variable in the navy bean model.[1]

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[1] *Supra*, p. 40.

This model in six equations contains 10 endogenous variables. Discussion of conditions for closing the model has been postponed until consideration of the restricted reduced form estimates of the parameters.

Price-demand structure for blackeyes:

$$y_{15t} = f\ (y_{16t}, \hat{y}_{11t}, x_{1t})$$

$$y_{17t} = f\ (y_{16t}, \hat{y}_{11t}, x_{9t})$$

$$y_{15t} + y_{17t} = x_{9t}$$

where

y_{15t} = production t + beginning stocks t - ending stocks t in pounds per capita

y_{16t} = average price of blackeyes in cents per pound in t

y_{17t} = ending stocks of blackeyes in pounds per capita in t

$\hat{y}_{11t}$ = average price of navy beans in cents per pound in t (computed)[1/]

x_{9t} = production t blackeyes + beginning stocks t blackeyes in pounds per capita.

Price-demand structure for large and small limas:

$$y_{18t} = f\ (y_{22t}, y_{23t}, x_{1t})$$

$$y_{19t} = f\ (y_{22t}, y_{23t}, y_{24t}, x_{10t})$$

$$y_{24t} = f\ (y_{23t}, y_{28t}, x_{12t}, x_{10t}, x_{1t})$$

$$y_{20t} = f\ (y_{18t}, y_{22t}, y_{23t}, x_{1t})$$

$$y_{21t} = f\ (y_{18t}, y_{23t}, y_{25t}, x_{11t})$$

$$y_{25t} = f\ (y_{18t}, y_{22t}, y_{29t}, x_{13t}, x_{11t}, x_{1t})$$

[1/] Supra, p. 41.

where

y_{18t} = production t + beginning stocks t - ending stocks t - government takeover t of large limas in pounds per capita

y_{19t} = ending stocks of large limas in pounds per capita in t

y_{20t} = production t + beginning stocks t - ending stocks t - government takeover t of small limas in pounds per capita

y_{21t} = ending stocks of small limas in pounds per capita in t

y_{22t} = wholesale price of large limas in cents per pound in t

y_{23t} = wholesale price of small limas in cents per pound in t

y_{24t} = government takeover of large limas in pounds per capita in t

y_{25t} = government takeover of small limas in pounds per capita in t

y_{28t} = difference between actual market price of large limas in t and support price in t

y_{29t} = difference between actual market price of small limas in t and support price in t

x_{10t} = production t + beginning stocks t of large limas in pounds per capita.

x_{11t} = production t + beginning stocks t of small limas in pounds per capita

x_{12t} = support price of large limas in cents per pound in t

and

x_{13t} = support price of small limas in cents per pound in t.

This model in six equations contains 10 endogenous variables. Discussion of conditions for closing the model has been postponed until consideration of the restricted reduced form estimates of the parameters.

A few final remarks are in order before specifying the stochastic character of the models. Although there have been domestic sales of all classes of beans from CCC stocks now and then, these were particularly heavy during 1950-51, especially for navy beans and small whites (Appendix Table 2). Because of allotments in that year, both the navy bean and the small white crops were relatively small. Although CCC domestic sales of small whites were very large, about half of these quantities ended up in commercial stocks, and their prices were very high (Appendix Table 3). On the other hand, demand for all kinds of beans was very strong that year because of military requirements. On the basis of price behavior in that year, it was decided that effects from CCC domestic sales and effects from military requirements were offsetting for small whites and for all other classes except navy beans. In order not to disturb the ending stocks for small whites in 1950-51, they were assumed to be at their previous year's level.

With respect to navy beans, a relatively small crop would logically have resulted in higher prices. This did not happen, however, because CCC sales were heavy. Yet, if CCC sales were fully included in disappearance, total disappearance would be unreasonably high at the resulting prices for navy beans and its competitors. To include only a portion of CCC sales as disappearance would have been arbitrary and unreasonable. Consequently, they were considered fully as disappearance, and a zero in the dummy variable already mentioned was replaced by 1 to take account of an extraordinary military demand. To be consistent, further domestic sales of CCC stocks of navy beans were also considered as disappearance, but these amounts were much smaller (Appendix Table 2).

The Stochastic Models

In order that meaningful inferences can be drawn from the behavioral equations presented in the preceding pages, for each model it is assumed that the observations on the jointly determined variables y_{it} are a constant linear function of the observations on the variables x_{it} and of drawings from populations of random disturbances. Furthermore:

$E\ U\ (t) = 0;$ $t = (1, \ldots, T)$	(or each disturbance vector has a zero expectation)
$E\ U\ (t)\ U'\ (t) = \Sigma;$ $t = (1, \ldots, T)$	(or the contemporaneous covariance matrix of the disturbances in the different equations is the same for all t)
$E\ U\ (t)\ U'\ (t') = 0;$ $t, t' = (1, \ldots, T)$ $t \neq t'$	(or all lagged covariances between disturbances in the same or different equations are zero)
$E\ X\ (t)\ U'\ (t) = 0;$ $t = (1, \ldots, T)$	(or the exogenous variables are independent from the disturbances)

Statistical theory has proven that least-squares estimation of the behavioral equations in the models would result in biased estimates of the parameters. This is so because in every relation one or more of the variables designated as independent in fact depend upon the values assumed by the disturbance. These are the endogenous jointly determined variables (y_i) on the right-hand side of every equation. Other methods of estimation have to be used to provide at least asymptotically unbiased estimates of the parameters.

The equations in the models presented are either just identified or overidentified according to the order condition. The conditions for identifiability of a structural equation when the restrictions on the structural equation are exclusions of variables are simply stated here, not established. In a simultaneous linear structural equation model, a particular equation is identifiable only if the rank of the matrix of the reduced form coefficients of the variables excluded from that structural equation in the reduced form relations of the included endogenous variables in the structural equation equals the number of included endogenous variables minus one. This is known as the rank condition.

Because the rank of a matrix cannot exceed the number of rows of the matrix (here equal to the number of endogenous variables included in the relation), the rank condition implies that a necessary condition for a particular structural equation to be identified is that the number of exogenous variables excluded from the structural equation must be greater than or equal to the number of endogenous variables included minus one. This is known as the order condition. If the number is greater, overidentification is indicated. If the number is equal, the equation is just identified.

For just identified relations, indirect least squares is a correct method. We can estimate every y_i as a function of all predetermined variables. The estimates hereby obtained are called reduced form estimates. Through algebraic manipulation of these, we can derive unique estimates for the structural parameters of an equation in the just identified case.

For overidentified equations in a model, the two-stage, least-squares procedure is the most simple and seems to do as well as any other method for small sample sizes. It involves the estimation of every nonnormalized y_i (or the y_i in the independent positions) as a function of all or part of the exogenous variables. Let us call these variables $\hat{y}_i$. Then, $E\ \hat{y}_i\ (t)\ U'\ (t) = 0$ because the x's from which they are computed are assumed to be uncorrelated with the disturbance term. Replacing all nonnormalized y_i by $\hat{y}_i$, we may then proceed to obtain asymptotically unbiased estimates of the structural parameters of every overidentified equation through the use of classical least squares. Furthermore, the indirect least-squares method and the two-stage, least-squares procedure lead to the same result in just identified relations.[1]

The two-stage, least-squares procedure was used here to arrive at estimates of the structural equations presented. The relevant data are summarized in Tables 13 and 14.

The Results

Estimates of the structural parameters are given in four significant digits. The estimated standard error of each coefficient appears beneath it in parentheses. The standard errors of estimate on the equation are denoted by S. The Durbin-Watson statistic for measuring serial correlation in disturbances is denoted by d. The coefficient of multiple determination is shown as R^2. The two-stage, least-squares results are:

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[1] The preceding discussion was merely a collection of accepted statistical theories relevant to this study. These and other topics can be studied in detail with the help of several excellent books:

John Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1963), 300p.

Goldberger, op. cit.

Lawrence Robert Klein, A Textbook of Econometrics (Evanston, Illinois: Row, Peterson and Company, 1953), 355p.

Edmond Malinvaud, Methodes Statistiques de l'econometrie (Paris: Dunod, 1964), 634p.

TABLE 13

Endogenous Variables: Data Used to Estimate the Price-Demand Parameter Structure of Some Categories of Dry Edible Beans, 1948-49 through 1963-64

Year	y_7	y_8	y_9	y_{10}	y_{11}	y_{12}	y_{13}	y_{14}	y_{15}	y_{16}	y_{17}	y_{18}	y_{19}	y_{20}	y_{21}	y_{22}	y_{23}	y_{24}	y_{25}
1948-49	2.661	.337	.004	7.76	8.10	8.83	.171	.451	.581	6.29	.169	.668	.109	.436	.008	17.78	8.48	.000	.260
1949-50	2.335	.405	.014	6.72	7.16	7.49	.000	1.228	.352	12.46	.025	.860	.003	.470	.009	9.32	7.23	.159	.374
1950-51	3.435	.248	.014	7.35	7.53	10.39	.000	.006	.399	14.39	.029	.752	.095	.507	.055	11.52	7.00	.000	.195
1951-52	2.369	.378	.048	7.93	7.83	8.12	.126	.736	.549	9.30	.078	.795	.060	.346	.021	11.51	6.48	.000	.207
1952-53	a/																		
1953-54																			
1954-55	1.923	.455	.001	8.37	10.34	11.48	.000	.000	.479	11.36	.040	.595	.030	.302	.056	11.08	6.19	.148	.197
1955-56	2.331	.493	.043	[illegible]	7.34	8.24	.000	.376	.465	6.51	.136	.592	.078	.212	.035	10.56	7.58	.010	.000
1956-57	2.032	.460	.039	6.77	7.39	8.08	.000	1.036	.455	8.02	.086	.559	.062	.225	.036	10.70	5.82	.062	.104
1957-58	2.082	.471	.010	9.44	9.18	9.64	.000	.018	.492	7.72	.054	.570	.028	.197	.039	11.25	7.60	.013	.000
1958-59	2.895	.426	.041	7.49	7.31	9.18	.000	.005	.481	7.33	.097	.558	.061	.228	.011	10.95	7.86	.033	.002
1959-60	3.321	.484	.085	7.13	6.29	7.47	.001	.099	.471	7.28	.095	.534	.039	.232	.009	12.04	8.10	.000	.000
1960-61	2.491	.398	.027	7.68	6.53	9.08	.000	1.136	.389	10.86	.019	.427	.029	.262	.004	16.93	11.00	.000	.000
1961-62	2.601	.251	.013	7.16	6.85	10.36	.000	1.274	.490	7.15	.054	.391	.058	.218	.032	15.13	8.12	.000	.000
1962-63	3.130	.298	.048	8.90	[illegible]	9.45	.000	[illegible]	.345	8.75	.055	.481	.084	.268	.042	11.30	8.42	.000	.000
1963-64	3.408	.319	.012	7.43	6.85	9.44	.000	.764	.417	10.67	.044	.444	.042	.281	.046	11.49	6.50	.008	.000

(Continued on next page.)

TABLE 13--continued.

a/ Blanks indicate no data available in sufficient detail to be included in the analysis.

Source: Derived from data presented on production, CCC acquisitions and sales, stocks, and prices.

TABLE 14

Exogenous Variables: Data Used to Estimate the Price-Demand Parameter Structure of Some Categories of Dry Edible Beans 1948-49 through 1963-64

Year	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}
1948-49	.231	3.112	2.894	.512	8.07	8.27	0	8.07	.750	.777	.704	9.92	8.52
1949-50	.315	3.563	2.140	.419	7.00	7.20	0	7.23	.377	1.022	.853	8.85	7.25
1950-51	.385	3.441	1.183	.322	6.92	6.97	1	7.44	.428	.847	.757	8.62	7.02
1951-52	.412	3.105	1.151	.552	7.84	7.89	0	7.85	.627	.855	.574	10.04	6.44
1952-53	a/												
1953-54													
1954-55	.501	2.013	1.244	.456	8.16	7.81	0	9.95	.519	.773	.555	10.81	6.06
1955-56	.548	2.707	1.218	.536	7.18	6.76	0	7.84	.621	.680	.247	9.76	5.01
1956-57	.577	3.068	1.103	.499	7.13	6.71	0	7.33	.541	.683	.365	9.71	4.96
1957-58	.604	2.100	0.901	.481	7.04	6.92	0	9.09	.546	.611	.236	9.67	4.92
1958-59	.642	2.900	1.193	.467	6.92	6.80	1	7.78	.578	.652	.241	9.55	4.80
1959-60	.663	3.420	1.320	.569	6.18	6.06	1	6.09	.566	.573	.241	8.81	4.21
1960-61	.683	3.627	0.923	.425	6.21	6.09	0	6.20	.408	.456	.266	8.88	4.24
1961-62	.723	3.875	0.950	.264	6.90	7.21	0	7.16	.544	.449	.250	10.08	5.28
1962-63	.756	3.646	.814	.346	6.90	7.33	1	7.00	.400	.565	.310	10.20	5.40
1963-64	.788	4.172	1.218	.331	6.90	7.33	1	6.56	.461	.494	.327	10.20	5.40

(Continued on next page.)

TABLE 14--continued.

a/ Blanks indicate no data available in sufficient detail to be included in the analysis.

Source: Derived from data presented on production, CCC acquisitions and sales, stocks, and prices.

Price-demand structure for white classes of dry edible beans:

$$y_{7t} = 3.62477 - \underset{(.09190)}{.28322}\, y_{11t} + \underset{(.05373)}{.08269}\, (y_{10t} + y_{12t})^{\underline{1/}}$$

$$- \underset{(.41081)}{.90644}\, x_{1t} + \underset{(.12587)}{.78091}\, x_{7t} + u_{7t}$$

$R^2 = .92$ S = .18437 d = 2.81 (i)$^{\underline{2/}}$

$$y_{14t} = -1.58754 - \underset{(.05564)}{.01929}\, (y_{10t} + y_{12t}) + \underset{(.18235)}{.01105}\, y_{26t}$$

$$+ \underset{(.46998)}{.55279}\, x_{1t} + \underset{(.18010)}{.69240}\, x_{2t} + \underset{(.15200)}{.03092}\, x_{5t} - \underset{(.18236)}{.81436}\, x_{7t} + u_{8t}$$

$R^2 = .92$ S = .19310 d = 3.02 (i)

$$y_{8t} = .32261 + \underset{(.01876)}{.08889}\, y_{11t} - \underset{(.01677)}{.08568}\, y_{12t} + \underset{(.09968)}{.30965}\, x_{1t} + u_{9t}$$

$R^2 = .74$ S = .04852 d = 2.02 (n)

$$y_{13t} = -.62231 - \underset{(.01818)}{.05285}\, y_{11t} + \underset{(.01909)}{.03245}\, y_{27t} - \underset{(.06045)}{.11106}\, x_{1t}$$

$$+ \underset{(.18029)}{.55341}\, x_{4t} + \underset{(.02629)}{.11209}\, x_{6t} + u_{10t}$$

$R^2 = .86$ S = .02544 d = 2.27 (i)

$$y_{9t} = .00880 - \underset{(.00834)}{.02011}\, y_{11t} + \underset{(.00979)}{.00892}\, y_{12t} - \underset{(.09299)}{.10254}\, y_{13t} + \underset{(.09663)}{.25011}\, x_{4t} + u_{11t}$$

$R^2 = .71$ S = .01542 d = 2.59 (i)

$$y_{10t} = 3.09932 + \underset{(.22027)}{.48622}\, y_{11t} - \underset{(.58355)}{.07555}\, x_{3t} + \underset{(2.0561)}{1.73402}\, x_{1t} + u_{12t}$$

$R^2 = .39$ S = .72001 d = 2.48 (i)

1/ Coefficients on y_{10t} and y_{12t} were nearly identical; to save on degrees of freedom, y_{10t} and y_{12t} were added together and the equation run again.

2/ Where the symbol (i) follows the statistic d, the Durbin-Watson test for serial correlation of the error term was inconclusive; (n) indicates that the test showed no serial correlation.

Price-demand structure for blackeyes:

$$y_{15t} = .61857 + \underset{(.01169)}{.01659}\,\hat{y}_{11t} - \underset{(.00497)}{.021843}\,y_{16t} - \underset{(.07372)}{.15951}\,x_{1t} + u_{13t}$$

$R^2 = .74$ $S = .04014$ $d = 2.32$ (n)

$$y_{17t} = -.04649 - \underset{(.00481)}{.00224}\,\hat{y}_{11t} - \underset{(.00734)}{.00743}\,y_{16t} + \underset{(.11436)}{.36962}\,x_{9t} + u_{14t}$$

$R^2 = .76$ $S = .02420$ $d = 2.12$ (n)

Price-demand structure for limas:

$$y_{18t} = 1.23907 - \underset{(.00659)}{.03277}\,y_{22t} + \underset{(.01686)}{.02424}\,y_{23t} - \underset{(.06442)}{.77652}\,x_{1t} + u_{15t}$$

$R^2 = .96$ $S = .03444$ $d = 1.51$ (i)

$$y_{19t} = .12194 + \underset{(.00456)}{.00789}\,y_{22t} - \underset{(.01586)}{.02607}\,y_{23t} - \underset{(.32217)}{.73945}\,y_{24t} + \underset{(.06190)}{.08727}\,x_{10t} + u_{16t}$$

$R^2 = .48$ $S = .02578$ $d = 2.81$ (i)

$$y_{28t} = 34.82951 + \underset{(.74234)}{.82261}\,y_{23t} + \underset{(13.37828)}{14.46928}\,y_{24t} - 23.69600^{1/}\,x_{1t}$$

$$- \underset{(3.34720)}{26.87131}\,x_{10t} - \underset{(.76117)}{.79155}\,x_{12t} + u_{17t}$$

$R^2 = .96$ $S = 1.07441$ $d = 1.67$ (i)

$$y_{20t} = -4.85796 + \underset{(.01181)}{.14110}\,y_{22t} - \underset{(.01210)}{.09951}\,y_{23t} + \underset{(.34519)}{4.35855}\,y_{18t}$$

$$+ \underset{(.27002)}{2.90368}\,x_{1t} + u_{18t}$$

$R^2 = .98$ $S = .01778$ $d = 2.40$ (i)

1/ Severe multicollinearity plagued this equation. Therefore, it was re-estimated after normalization on y_{28t} rather than y_{24t} and taking out the influence of income before estimation, using its coefficient from the demand equation.

$$y_{21t} = .16107 - \underset{(.00627)}{.01309}\, y_{23t} - \underset{(.07994)}{.09927}\, y_{18t} - \underset{(.25715)}{.09627}\, y_{25t} + \underset{(.12663)}{.08251}\, x_{11t} + u_{19t}$$

$R^2 = .37$ $\qquad$ $S = .01749$ $\qquad$ $d = 2.12$ (n)

$$y_{25t} = 4.69705 - \underset{(.16208)}{4.20760}\, y_{18t} - \underset{(.09549)}{.13745}\, y_{22t} + \underset{(.01908)}{.10670}\, y_{29t} - 2.90368\, x_{1t}^{\underline{1}/}$$

$$+ \underset{(.11857)}{.97589}\, x_{11t} + \underset{(.03583)}{.09871}\, x_{13t} + u_{20t}$$

$R^2 = .98$ $\qquad$ $S = .03025$ $\qquad$ $d = 2.50$ (i)

In general, the results obtained from the process of estimation were very satisfactory. All structural coefficients exhibit signs consistent with economic theory and evidence. From the estimates obtained, elasticities at the means were computed; they are presented in Table 15.

Demands for small whites and small limas are more sensitive to price changes than demands for navy beans and large limas. This confirms the relative importance of navy beans in the white class (and the relative unimportance of small whites) and large limas in the other class sector (and the relative unimportance of small limas). However, negative income elasticity for navy beans of -1.62 is somewhat surprising. It has to be considered together with the effect of the dummy variable introduced in the demand equation for navy beans. It is unfortunate that the real causes could not be found for the sudden surge in commercial disappearance of navy beans in some recent years of the observation period.

In his study, Hathaway does not explicitly furnish the data used. However, from a graphical illustration and a quantitative statement about the decrease in price caused by an increase in supply of navy beans, a price elasticity of

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1/ To avoid extreme multicollinearity, the influence of income was taken out before estimation, using its coefficient from the demand equation.

TABLE 15

Price and Income Elasticities of Demand of Dry Edible Beans by Variety

Variety	Own price	Competing Price	Income
Navy	- .81	+ .52	-1.62
Small whites	-2.01	+1.73	+ .55
Blackeyes	- .44	+ .28	- .35
Small limas	-2.50	+5.78	+5.19
Large limas	- .68	+ .31	-1.38

Source: Elasticities derived from the estimated demand relationships.

demand of -.35 was computed (period of observation ran through 1952; mean of quantity used, 4.25 million hundredweight; mean of price, $6.00 per hundredweight).[1] It is impossible to compare the income elasticity of demand for navy beans computed in this study with Hathaway's result since "the intercorrelation between production of Great Northern beans and disposable consumer income is believed to be the major reason for the sign of the regression coefficient for the supply of Great Northern beans being opposite from that expected. Even though statistically significant it is not believed that this regression coefficient is structurally correct. When this variable is dropped from the model, the regression coefficient for disposable consumer income changes substantially and it is believed that this regression coefficient is also non-structural. . . ."[2]

A correct interpretation of the elasticity measures with respect to the demand for small limas must take into account the fact that a 1 percent change in the quantity of large limas demanded changes the quantity of small limas demanded by 8.54 percent in the same direction. For example, the real effect of an increase in income on the quantity of small limas demanded at constant prices of large and small limas is negative, not positive.

Impact of Governmental Support Programs on the Production, Disappearance, and Prices of Some Important Varieties of Dry Edible Beans

The information obtained so far can be used in principally two ways to infer what the impact of governmental programs has been in the dry edible bean sector. First, general conclusions can be drawn from the estimated parameter structure without further manipulation. Second, structural reduced forms can be obtained as a basis for simulating the behavior of the dry edible bean market under various hypotheses with respect to governmental interference. The latter approach gives us an automatic system for tracing through the impact of any changes worth considering. Before pursuing that approach, however, a few general considerations are in order.

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[1] Hathaway, *op. cit.*, pp. 46-47.

[2] *Ibid.*, p. 69.

Results from the supply response models indicate that, although the responses are inelastic with respect to price in the short run, they are elastic considered over a longer period of time. It is, therefore, dangerous to decide on the supply stimulus of a support program when only short-run estimates are at one's disposal.

One might think that constant ratios maintained among the support prices of several classes of beans would protect all varieties to the same extent over time. But nothing could be less true. First of all, technological advances in the production of those varieties may proceed at unequal speeds; and secondly, the income development from other competing crops may be quite different. In the practical case at hand, although incomes received from competing crops have been nearly the same, navy bean yields have increased faster than those of other varieties.

The models considered here illustrate two important factors often overlooked in more partial analyses. Lack of interdependency among some commodities in one part of the total structure does not necessarily mean that the same lack of interdependency holds for the other part. For example, small whites and navy beans are interdependent on the demand side but independent on the supply side; limas and other white varieties are largely independent on the demand side but interdependent on the supply side. Also, if support price in t has no influence on supply in t but takeover actually occurs, this results in supply t+1 being dependent on support price in t.

An important question relates to the effect of the disposal of CCC acquisitions of one variety, while support prices for the other varieties have become ineffective. Two assumptions could be made: (1) that the dispositions of the commodity in surplus at the support price involve consumers who formerly did not consume any of the competing commodities (case 1) or (2) that the disposition of surpluses of that one commodity does partially occur in markets that already are consuming some amounts of the competing commodities (case 2). For clarity of exposition, we start with case 1.

To facilitate the analysis, the following diagram has been drawn (Figure 2). The demand curve for the commodity whose support price has become ineffective is drawn as d_1d_1' on the assumption of a free-market price p_2 for the commodity whose support price will be effective.[1] The demand curve for commodity 2 is represented by d_2d_2' on the assumption of a free-market price equal to p_1 for commodity 1. Suppose that p_1 and p_2 are last period's prices and that we are in equilibrium so that supplies s_1 and s_2 are generated and equilibrium is maintained. Assume, also, that for the present period a support price for commodity 2 of sp_2 has been set. It is not basic to the present analysis whether this year's supply of commodity 2 is affected by the support price or only next year's supply. To fix ideas, assume that the support price is announced after planting.

For the present year, then, the demand curve for commodity 1 shifts to the right as a consequence of a higher price than p_2 for commodity 2. The magnitude of this shift depends on the cross-elasticity of demand of commodity 1 versus

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[1] From hereon, the commodity whose price is not supported will be called commodity 1; the other, commodity 2. The assumption is, of course, that the two commodities are substitutes (competing commodities).

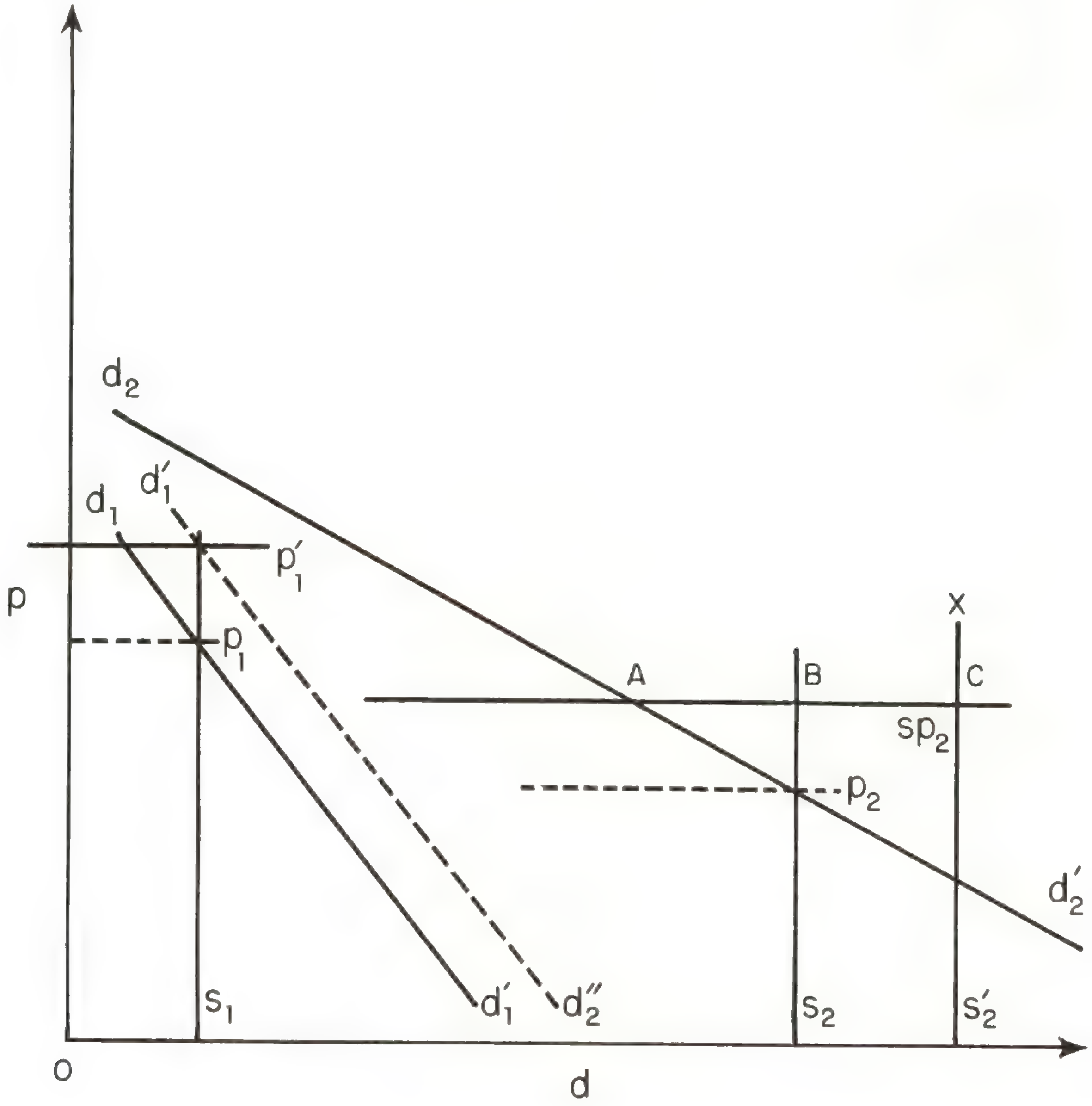

FIGURE 2 Graphical Representation of Price and Demand Interrelationships for Two Commodities (Substitutes in Consumption) When One of Them is Directly Influenced by a Price-Support Program

commodity 2. The new demand curve for commodity 1 is represented on the graph by the broken line d_1d_1''. The new price resulting for commodity 1 is now p_1'. The amount of commodity 2 delivered to the government, under the assumption that s_2 is the given supply, depends on the height of the support price above what free-market forces would bring and the slope of the demand curve for commodity 2 . Note that somewhat less than the amount AB of commodity 2 will be delivered to the government as d_2d_2' also shifts to the right as a consequence of a higher price for commodity 1.

The foregoing analysis is a one-period analysis. If the support price of sp_2 continues over time for commodity 2 and a normal supply per period of s_2' results, there will be deliveries to the government every period in the amount of AC. If the disposal of these deliveries can lead to market creation, the support price sp_2 can eventually become the free-market price again. However, technological progress in the production of commodity 2 may also shift the supply outward, and the actual takeover then would be determined by the magnitude of the counteracting forces of market creation and supply shifts. In any case, the producers of commodity 2 get either an outright gift or a free-market creation program or both.

The benefits through time to commodity 1, under the assumption of a stable situation, will consist of a price higher than p_1 but lower than p_1', and a quantity sold will be higher than s_1. Indeed, if for an indefinite period the price of commodity 2 is sp_2 and the situation is stable, an equilibrium for commodity 1 must be reached with price between p_1 and p_1' and supply above s_1 as p_1' and s_1 are not in mutual equilibrium. What the exact increases above p_1 and s_1 will be will depend on the demand and supply responses to price for that commodity and on its cross-elasticity of demand with respect to commodity 2.

Under a normal situation, the benefits to commodity 1 will certainly be only of second order importance compared to the benefits accruing to the producers of commodity 2.

Any benefits to commodity 1 could easily be wiped out if the disposal of deliveries of commodity 2 to the government took the form of donations of that commodity to consumers of commodity 1. For in that case, the inward shift of the demand curve for commodity 1 could cancel or surpass its outward shift, resulting in a "worse off" situation.

Simulation of the Impact of Governmental Programs in the Dry Edible Bean Sector

The estimated supply structure and price-demand structure will be used to arrive at a quantitative estimate of the influence of the price-support programs in the dry edible bean sector. Two ways are open to accomplish this.

First, after obtaining the price-demand structures in their reduced form, we could combine these with the supply equations to arrive at an integrated supply-demand model of the following form:

$$y_{(t)} = \Pi_1 y_{(t-1)} + \Pi_2 x_{(t)}$$

where

$y_{(t)}$ = G x 1 vector of endogenous variables

$x_{(t)}$ = K x 1 vector of exogenous variables

Π_1 = G x G matrix of coefficients

and

Π_2 = G x K matrix of coefficients.

If one is willing to assume with Zusman[1] that x_t may be represented by $B_0 + B_{1t}$ and, furthermore, that Π_1 is stable and that sufficient time has elapsed for the influence of the starting point to be negligible, then we may write

$$y_{(t)} = (I-\Pi_1)^{-1}\Pi_2(B_0 + B_{1t}) - (I-\Pi_1)^{-2}\Pi_1\Pi_2B_1$$

as representing the time path of the endogenous variables. If one is interested in the values of the endogenous variables immediately following a starting point, one must, of course, consider the original integrated system:

$$y_{(t)} = \Pi_1\, y_{(t-1)} + \Pi_2\, x_{(t)}.$$

If we are to use this approach here, quite a series of simplifications will have to be introduced to keep the system manageable; and we will have no idea in what way our results will have been affected. The following would be necessary simplifications:

1. Linearization of nonlinear terms in supply and demand equations.
2. Expression of exogenous variables as a function of time.
3. As no yield functions are available, use of average yields.
4. Use of supplies per capita, using the average population.

Therefore, supply equations and reduced form price-demand structures will be kept separate so that none of the above simplifications will be necessary. We will now proceed with this approach.

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[1] Pinhas Zusman, "Dynamic Discrepancies in Agricultural Economic Systems," Journal of Farm Economics, Vol. 44, No. 3 (August, 1962), pp. 744-753.

Every estimated structural relation of the price-demand models may be written as

$$y_1 + b_1 y_2 + \ldots + b_n y_n = a_1 x_1 + a_2 x_2 + \ldots + a_n x_n$$

where some of the b_i and a_i are zero. The models, expressed in matrix form, may then be written

$$By' = AX'$$

where

B = K x K matrix of coefficients on the endogenous variables

y = 1 x K vector of endogenous variables

A = K x T matrix of coefficients on the predetermined variables

and

X = 1 x T vector of predetermined variables.

Algebraic manipulation yields $y' = B^{-1}AX'$ which are the derived reduced form relations. In the case at hand, we have basically three structures: one for small whites, navy beans, and great northerns; one for blackeyes; and one for lima beans. The structures for white varieties and limas must be broken down in several cases with respect to governmental intervention. As a result, the following nine derived reduced form structures are presented.

1. Price-demand reduced form structure for white varieties. No deliveries to the government of either small whites or navy beans (free-market prices above support prices).

$$y_{7t} = 1.00000\ x_{2t}$$

$$y_{8t} = .27499 - .06679\ x_{1t} - .07173\ x_{2t} - .00045\ x_{3t} + .77908\ x_{4t} + .05602\ x_{7t}$$

$$
\begin{aligned}
y_{9t} &= -.27499 + .06679\ x_{1t} + .07173\ x_{2t} + .00045\ x_{3t} \\
&\quad + .22092\ x_{4t} - .05602\ x_{7t} \\
y_{10t} &= 15.24354 + .49780\ x_{1t} - 2.87839\ x_{2t} - .09353\ x_{3t} \\
&\quad - 2.32522\ x_{4t} + 2.24776\ x_{7t} \\
y_{11t} &= 24.97680 - 2.54250\ x_{1t} - 5.91993\ x_{2t} - .03698\ x_{3t} \\
&\quad - 4.78225\ x_{4t} + 4.62293\ x_{7t} \\
y_{12t} &= 26.46840 + 1.75582\ x_{1t} - 5.30450\ x_{2t} - .03314\ x_{3t} \\
&\quad - 14.05436\ x_{4t} + 4.14233\ x_{7t}
\end{aligned}
$$

2. Price-demand reduced form structure for white varieties. Deliveries to the government of small whites and navy beans.

In this case, prices are considered equal to the support prices. Quantities demanded and quantities delivered to the government are considered simultaneously determined; ending stocks are considered as a residual. The structure is:

$$
\begin{aligned}
y_{7t} &= 3.88111 - .76305\ x_{1t} - .24301\ x_{5t} + .08269\ x_{6t} \\
&\quad - .00625\ x_{3t} + .7809\ x_{7t} \\
y_{8t} &= .32261 + .30965\ x_{1t} + .08889\ x_{5t} - .08568\ x_{6t} \\
y_{9t} &= .29970 - .19859\ x_{1t} + .44659\ x_{4t} - .03604\ x_{5t} \\
&\quad - .02641\ x_{6t} \\
y_{10t} &= 3.09932 + 1.73402\ x_{1t} + .48622\ x_{5t} - .07555\ x_{3t} \\
y_{13t} &= -1.64743 - .11106\ x_{1t} + .55341\ x_{4t} - .05285\ x_{5t} \\
&\quad + .11209\ x_{6t}
\end{aligned}
$$

$$y_{14t} = -1.64743 + .51934\ x_{1t} + .69239\ x_{2t} + .02154\ x_{5t}$$

$$- .01929\ x_{6t} + .00149\ x_{3t} - .81439\ x_{7t}$$

3. Price-demand reduced form structure for white varieties. Deliveries to the government of navy beans, not of small whites.

Here, the price of navy beans is considered equal to the support price.

The structure is:

$$y_{7t} = 4.21911 - .42948\ x_{1t} - .16892\ x_{5t} - .80782\ x_{4t}$$

$$- .00625\ x_{3t} + .78091\ x_{7t}$$

$$y_{8t} = -.02767 - .03598\ x_{1t} + .01212\ x_{5t} + .83703\ x_{4t}$$

$$y_{9t} = .02767 + .03598\ x_{1t} - .01212\ x_{5t} + .16297\ x_{4t}$$

$$y_{10t} = 3.09932 + 1.73402\ x_{1t} + .48622\ x_{5t} - .07555\ x_{3t}$$

$$y_{12t} = 4.08819 + 4.03400\ x_{1t} + .89604\ x_{5t} - 9.76928\ x_{4t}$$

$$y_{14t} = -1.72619 + .44152\ x_{1t} + .69239\ x_{2t} + .00426\ x_{5t}$$

$$+ .18845\ x_{4t} + .00146\ x_{3t} - .81436\ x_{7t}$$

4. Price-demand reduced form structure for white varieties. Deliveries to the government of small whites, not of navy beans.

The price of small whites is considered equal to its support price.

The structure is:

$$y_{7t} = 1.00000\ x_{2t}$$

$$y_{8t} = 1.74222 + .03054\ x_{1t} - .36578\ x_{2t} - .05543\ x_{6t}$$

$$- .00229\ x_{3t} + .28564\ x_{7t}$$

$$\begin{aligned} y_{9t} &= -.27588 - .08543\ x_{1t} + .14830\ x_{2t} + .44659\ x_{4t} \\ &\quad - .03867\ x_{6t} + .00093\ x_{3t} - .11581\ x_{7t} \end{aligned}$$

$$\begin{aligned} y_{10t} &= 10.86448 + .20731\ x_{1t} - 2.00079\ x_{2t} + .16545\ x_{6t} \\ &\quad - .08805\ x_{3t} + 1.56243\ x_{7t} \end{aligned}$$

$$\begin{aligned} y_{11t} &= 15.97046 - 3.13955\ x_{1t} - 4.11498\ x_{2t} + .34027\ x_{6t} \\ &\quad - .02571\ x_{3t} + 3.21343\ x_{7t} \end{aligned}$$

$$\begin{aligned} y_{13t} &= -1.46635 + .05489\ x_{1t} + .21748\ x_{2t} + .55341\ x_{4t} \\ &\quad + .09411\ x_{6t} + .00136\ x_{3t} - .16983\ x_{7t} \end{aligned}$$

5. Reduced form structure for blackeyes.

$$y_{16t} = 19.54289 - 21.53444\ x_{9t} - 5.44904\ x_{1t} + .490211\ \hat{y}_{11t}$$

$$y_{17t} = -.19169 - .00588\ \hat{y}_{11t} + .52962\ x_{9t} + .04049\ x_{1t}$$

6. Price-demand reduced form structure for limas. No deliveries to the government.

$$y_{18t} = 1.31562 - 1.02413\ x_{1t} + 1.04486\ x_{10t} - 2.58278\ x_{11t}$$

$$y_{19t} = -1.31562 + 1.02413\ x_{1t} - .04485\ x_{10t} + 2.58278\ x_{11t}$$

$$y_{20t} = .88762 - .72565\ x_{1t} + .02645\ x_{10t} - .60750\ x_{11t}$$

$$y_{21t} = -.88762 + .72565\ x_{1t} - .02645\ x_{10t} + 1.60750\ x_{11t}$$

$$y_{22t} = 49.54421 - 27.70445\ x_{1t} - 36.25109\ x_{10t} + 7.12828\ x_{11t}$$

$$y_{23t} = 70.13658 - 47.66895\ x_{1t} - 5.90320\ x_{10t} - 96.91348\ x_{11t}$$

7. Price-demand reduced form structure for limas. Deliveries to the government of both small and large limas.

Actual prices are considered equal to the support price. Government takeovers and quantities demanded are determined simultaneously. Ending stocks are considered as residuals. The structure is:

$$y_{18t} = 1.23907 - .77652\ x_{1t} - .03277\ x_{12t} + .02424\ x_{13t}$$

$$y_{19t} = 1.16803 - .86115\ x_{1t} - .85712\ x_{10t} - .02193\ x_{12t} + .03261\ x_{13t}$$

$$y_{20t} = .54259 - .48082\ x_{1t} - .00173\ x_{12t} + .00614\ x_{13t}$$

$$y_{21t} = -.02613 + .11722\ x_{1t} - .87589\ x_{11t} + .00130\ x_{12t} - .00286\ x_{13t}$$

$$y_{24t} = -2.40710 + 1.63767\ x_{1t} + 1.85712\ x_{10t} + .05470\ x_{12t} - .05685\ x_{13t}$$

$$y_{25t} = -.51646 + .36361\ x_{1t} + .97589\ x_{11t} + .00043\ x_{12t} - .00328\ x_{13t}$$

8. Price-demand reduced form structure for limas. Deliveries to the government of large limas, not of small limas.

$$y_{18t} = 2.74361 - 1.82265\ x_{1t} - 2.37732\ x_{11t} - .02882\ x_{12t}$$

$$y_{19t} = 3.19209 - 2.26850\ x_{1t} - .85712\ x_{10t} - 3.19820\ x_{11t} - .01662\ x_{12t}$$

$$y_{20t} = .92377 - .74586\ x_{1t} - .60230\ x_{11t} - .00073\ x_{12t}$$

$$y_{21t} = -.92377 + .74586\ x_{1t} + 1.60230\ x_{11t} + .00073\ x_{12t}$$

$$y_{23t} = 62.06870 - 43.15700\, x_{1t} - 98.07427\, x_{11t} + .16284\, x_{12t}$$

$$y_{24t} = -5.93571 + 4.09114\, x_{1t} + 1.85712\, x_{10t} + 5.57552\, x_{11t} + .04544\, x_{12t}$$

9. Price-demand reduced form structure for limas. Deliveries to the government of small limas, not of large limas.

$$y_{18t} = -.55355 + .24618\, x_{1t} + 1.20218\, x_{10t} + .02665\, x_{13t}$$

$$y_{19t} = .55355 + .24618\, x_{1t} - .20218\, x_{10t} - .02665\, x_{13t}$$

$$y_{20t} = .44797 - .42598\, x_{1t} + .06345\, x_{10t} - .00627\, x_{13t}$$

$$y_{21t} = .04480 + .07673\, x_{1t} - .04757\, x_{10t} + .02411\, x_{11t} - .00295\, x_{13t}$$

$$y_{22t} = 54.70297 - 31.20257\, x_{1t} - 36.68529\, x_{10t} - .07355\, x_{13t}$$

After the above reduced form parameters had been computed, an effort was made to obtain a quantitative estimate of the development over time of the white bean sector under the absence of support prices. It was assumed that actual support prices for large and small limas were in effect. Consequently, the structures used in the computations were the supply equations, the price-demand reduced form structure for white classes (first case), the price-demand reduced form structure for blackeyes, and the appropriate price-demand reduced form structure for limas (to be considered for every period).

There were a few adjustments to and/or additional computations beyond the presented simulation structure. When acreages rather than production were obtained from the supply response models, these were converted into production with actual annual yield data. The dummy variable in the navy bean demand sector was assigned one only for the Korean War year 1950-51, not for any later years since we found no explanation for the sudden surge in commercial disappearance in some recent years. It is possible, although this can only be guessed, that this phenomenon is connected with governmental disposal programs. The support price in year t appears in the supply equation for great northerns. When this price was put equal to zero, an unrealistic low supply resulted. It was, therefore, assumed that in reality exclusion of the support price was accomplished by setting this price equal to the average of the last eight years when it was no longer effective. This price is considerably below the actual support price in earlier years.

A difficulty arose with respect to the years that were deleted from the supply response analysis because of temporary influential factors. For these years, a comparison was made between actual production and predicted production from the individual equations using actual data. If the difference was more than two standard errors of estimate, it was considered significant and added to or subtracted from the simulated production as the case might be. It was assumed that prices of corn and prices of feed grains and their yields would not significantly be influenced by developments in the dry bean sector. For computation of competing bean prices of California varieties, actual prices of pink beans and red kidney beans were taken. This was unavoidable since these beans had been excluded from the models. One final assumption was made; namely, that prices of small whites, navy beans, great northerns, and blackeyes could not fall under $3.00 per hundredweight. If it did happen, supply minus consumption at that price was added to next year's production. Starting points of the simulation runs were the prices received during 1947-48, acreages or production in that year, and ending stocks of that year. The results of this simulation have been summarized in Table 16. Graphic comparisons of actual versus simulated results are presented in Figures 3 through 10.

The results suggest that the lima bean sector is quite unstable, while the opposite can be said for the white varieties. Instability in the former sector may be due to the fact that the behavior assumed in the simulation model probably does not hold for either extremely high or extremely low prices of large and small limas.

It appears also that navy beans and great northerns have been helped considerably by the price-support program, particularly in more recent years. The results for great northerns do not agree with reality for more recent years; this might be due to the crude specification of its price-demand structure.

In the recent past, simulated prices of navy beans averaged around $5.00 per hundredweight, whereas the actual average is around $7.00 per hundredweight. The question can then be legitimately raised why support prices of navy beans are held around $7.00 per hundredweight in view of large CCC acquisitions, while support prices for a variety such as small limas have been lowered to around $5.00 per hundredweight to avoid CCC acquisitions.

Because large takeovers of navy beans have occurred every year since 1960-61, a further simulation exercise was run for the years 1958-59 through 1963-64, holding the price of navy beans constant at $6.86 (close to the level of the actual support price). Furthermore, it was assumed that one-fifth of the navy bean takeover would be donated to consumers of blackeyes and small whites with a limit of one-fifth of .850 pounds per capita (two-fifths of this in the small white market and three-fifths in the blackeye market). This simulation run will be called simulation 2, and its results are compared with simulation 1 in Table 17.

TABLE 16

Supplies and Prices of Dry Edible Beans Obtained on the Basis of the Estimate of the Parameter Structure and Under the Assumption of Absence of Governmental Support in the White Bean and Blackeye Bean Sector

Marketing year	Supplies						Prices					
	Navy	Small white	Great Northern	Blackeye	Large lima	Small lima	Navy	Small white	Great Northern	Blackeye	Large lima	Small lima
	per capita						cents per pound					
1948-49	3.102	.505	2.593	.667	.636	.759	3.50	3.23	5.01	5.64	23.54	8.52[a]
1949-50	2.370	.456	1.151	.376	1.218	.773	7.92	8.01	7.41	13.42	8.85[a]	7.25[a]
1950-51	1.704	.291	.303	.561	.886	.824	17.13	18.42	12.07	13.76	9.67	7.02[a]
1951-52	3.542	.946	1.676	.595	.810	.712	3.00[b]	3.00[b]	5.15	5.96	11.17	6.44[a]
1952-53	2.282	.437	.890	.403	.971	.558	8.17	8.98	7.80	12.41	11.80[a]	6.45[a]
1953-54	1.801	.306	.464	.545	.840	.420	11.69	13.39	9.53	11.08	11.80[a]	6.45[a]
1954-55	1.205	.542	1.198	.555	.787	.322	13.93	13.30	10.65	11.69	10.81[a]	10.62
1955-56	2.263	.568	1.800	.571	.758	.320	7.40	7.38	7.51	7.89	9.76[a]	8.62
1956-57	2.583	.456	1.429	.491	.656	.493	5.99	7.32	6.90	8.76	12.27	4.96[a]
1957-58	1.574	.332	1.012	.498	.722	.269	12.50	14.48	10.15	11.88	9.67[a]	11.19
1958-59	2.633	.596	1.173	.566	.620	.436	4.86	5.21	6.49	6.24	11.57	4.80[a]
1959-60	2.736	.318	.730	.446	.623	.233	5.55	8.63	6.13	9.05	10.25	12.27
1960-61	2.563	.428	.602	.502	.312	.363	5.82	8.04	7.15	7.68	21.63	4.24[a]
1961-62	2.836	.201	.565	.485	.787	.078	5.37	9.85	6.92	7.79	10.08[a]	24.86
1962-63	2.524	.349	.625	.481	.861	.606	6.42	9.48	7.48	8.21	10.20[a]	5.40[a]
1963-64	2.877	.333	.674	.448	.243	.252	4.32	7.89	6.51	7.72	20.70	6.72

(Continued on next page.)

TABLE 16--continued.

a/ Price hits support price.

b/ Price fixed at 3.00.

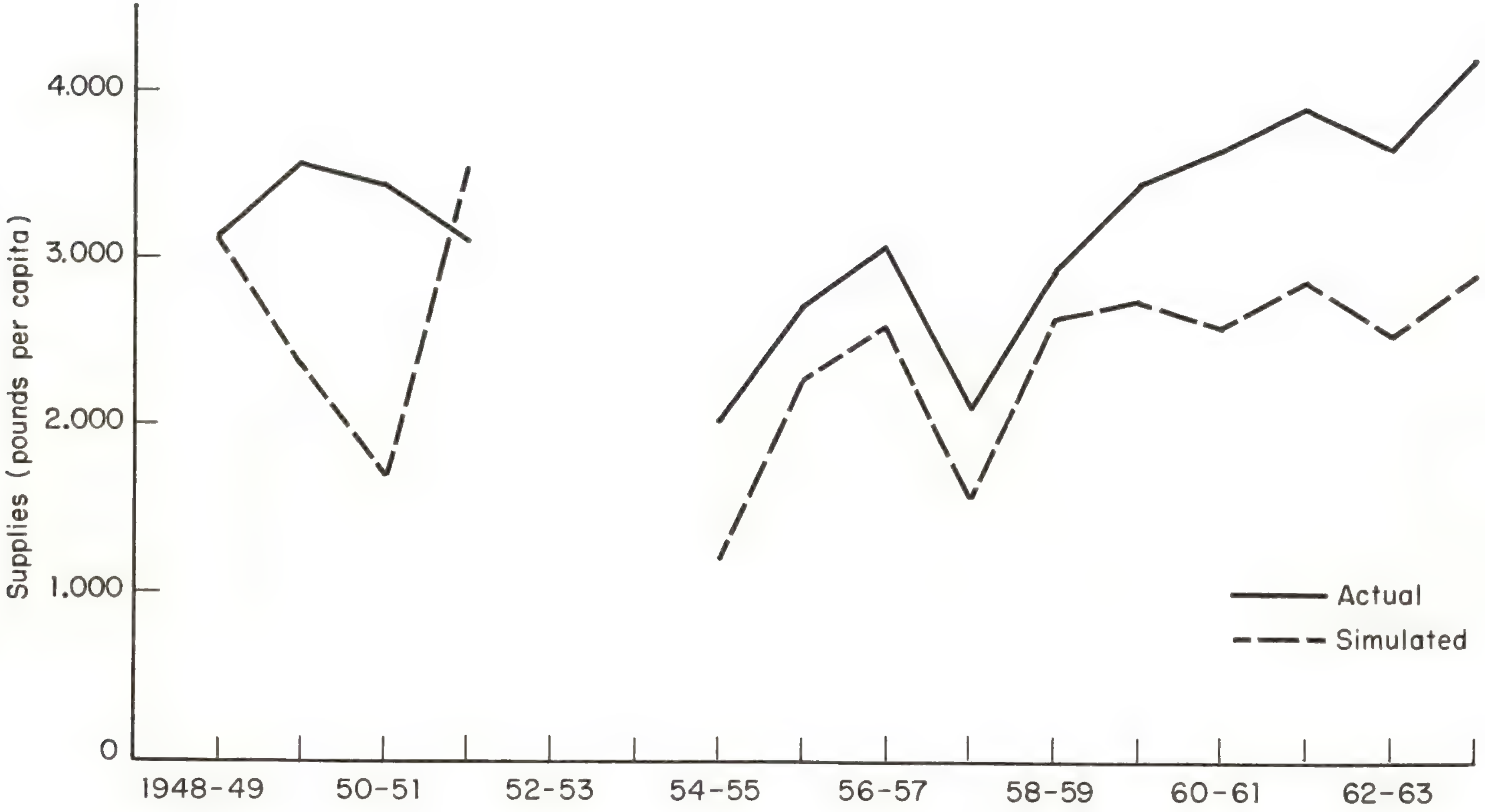

FIGURE 3 Navy Beans (Supplies Per Capita)

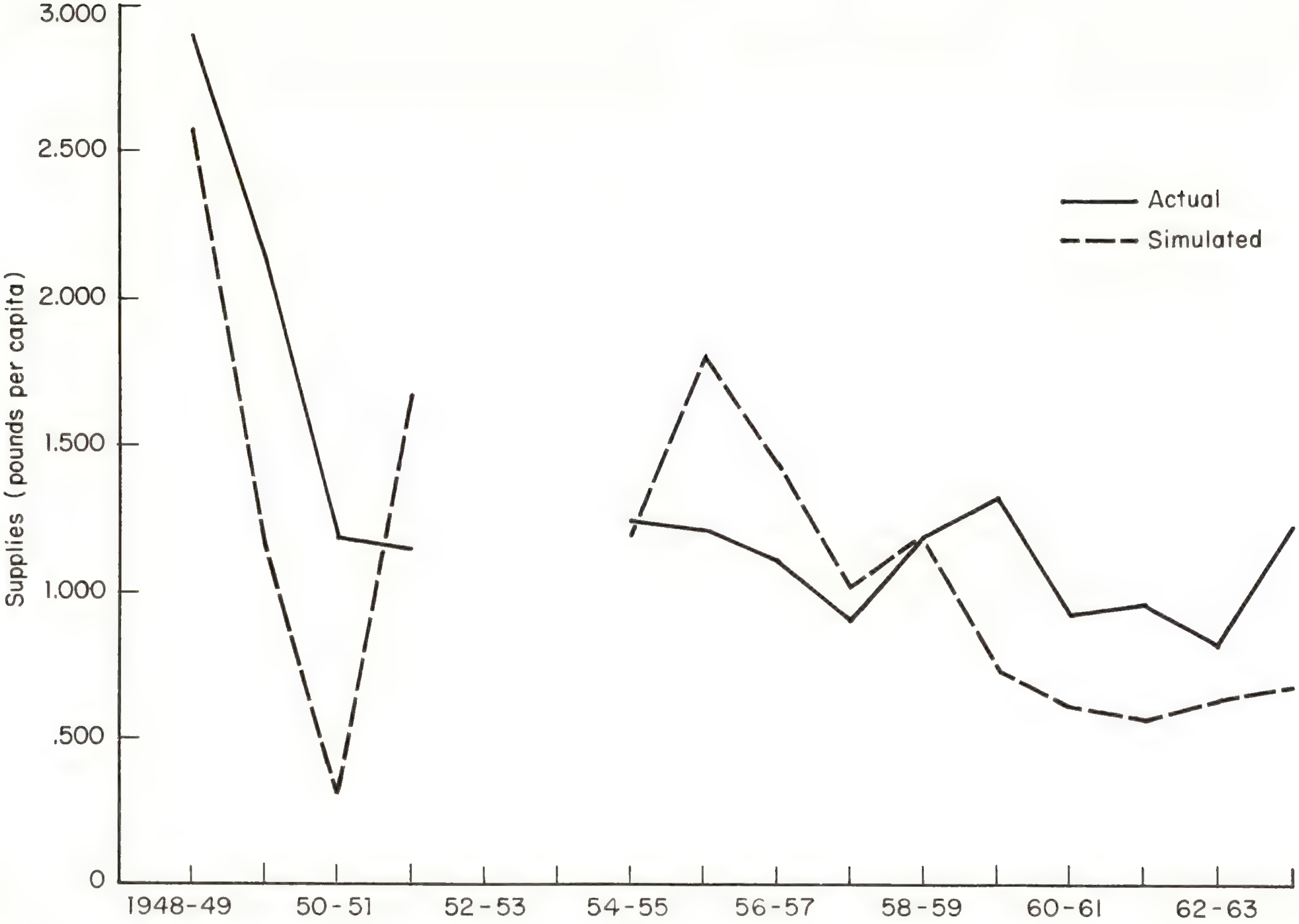

FIGURE 4. Great Northerns (Supplies Per Capita)

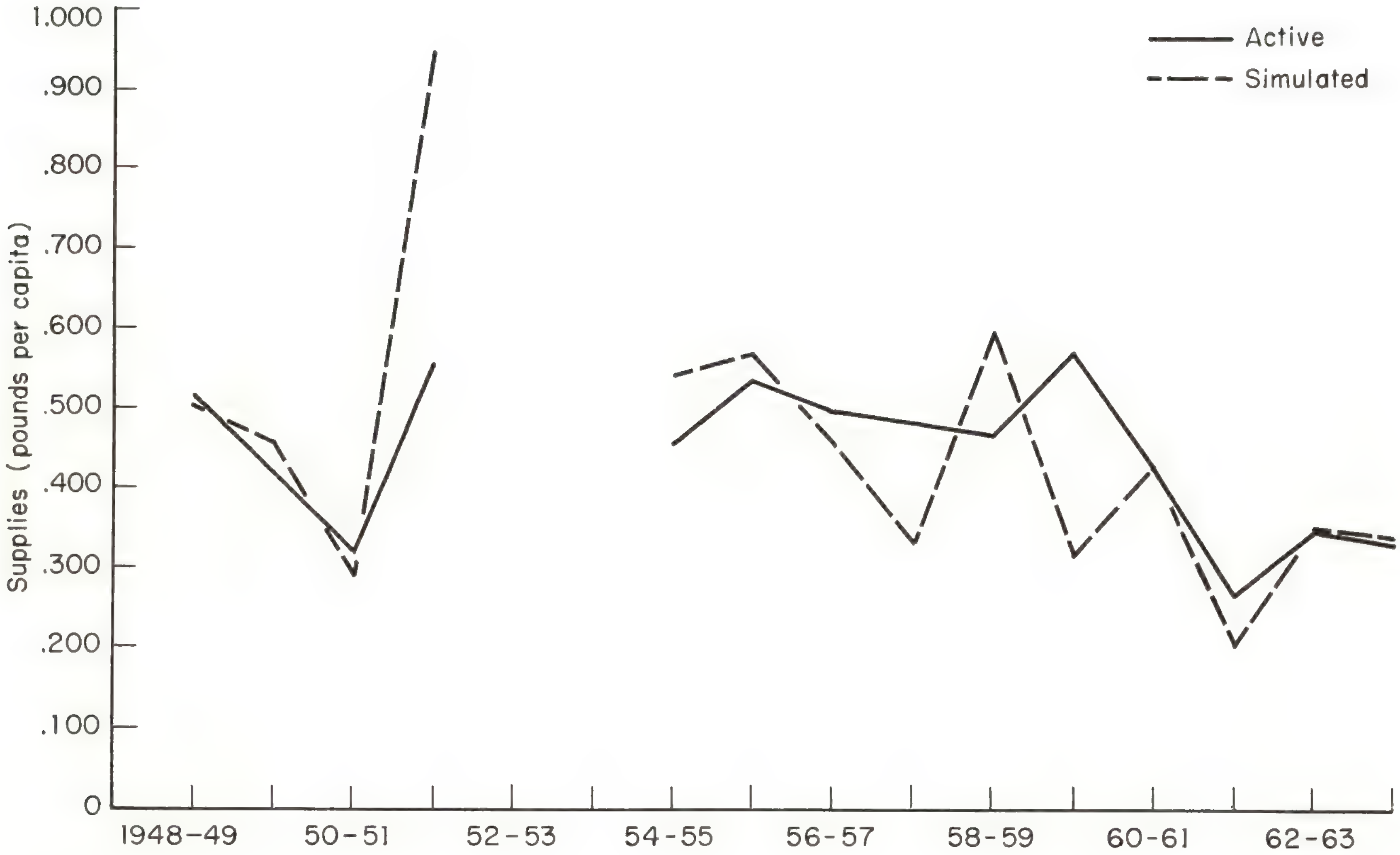

FIGURE 5. Small Whites (Supplies Per Capita)

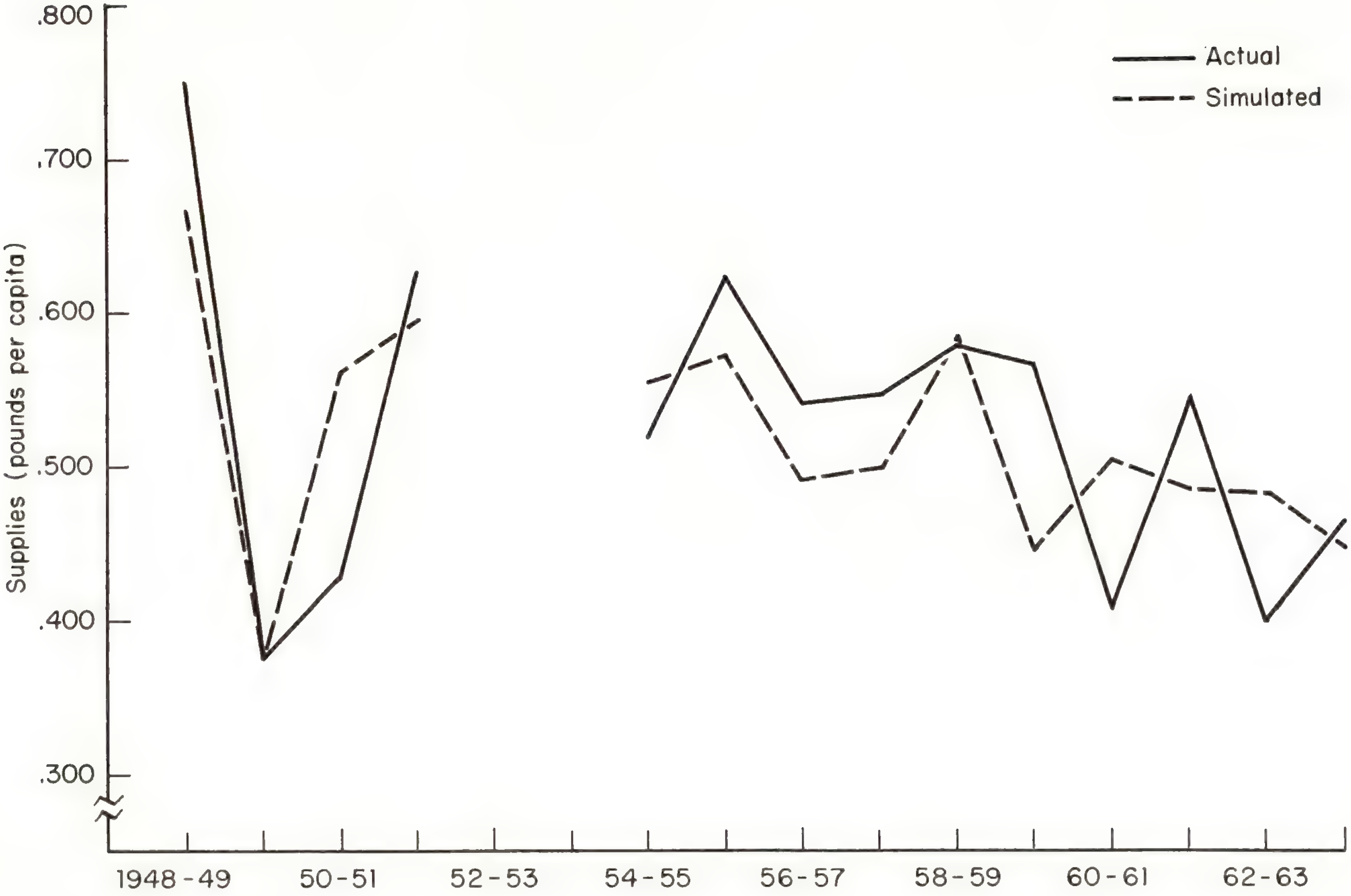

FIGURE 6. Blackeyes (Supplies Per Capita)

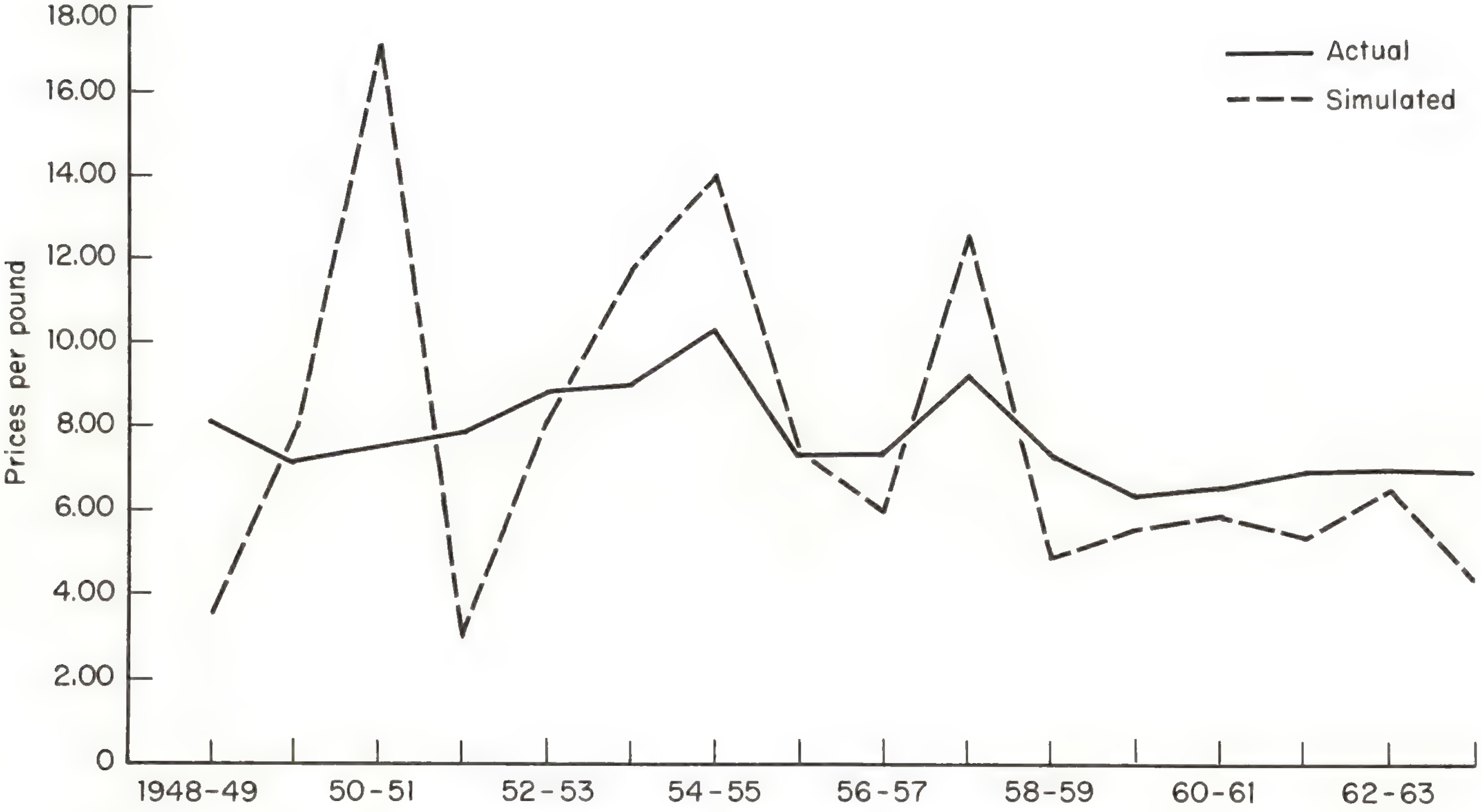

FIGURE 7. Navy Beans (Prices Per Pound)

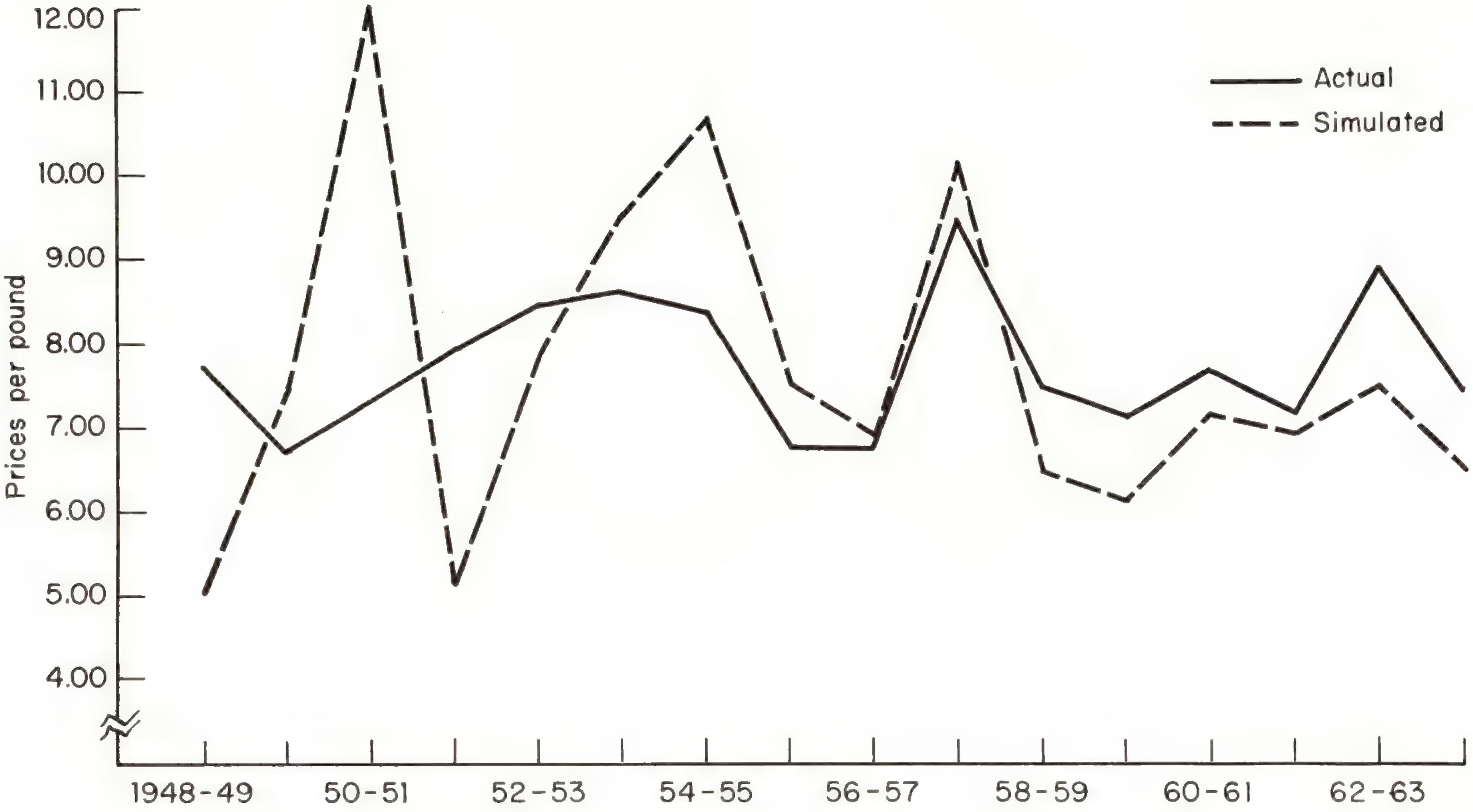

FIGURE 8. Great Northerns (Prices Per Pound)

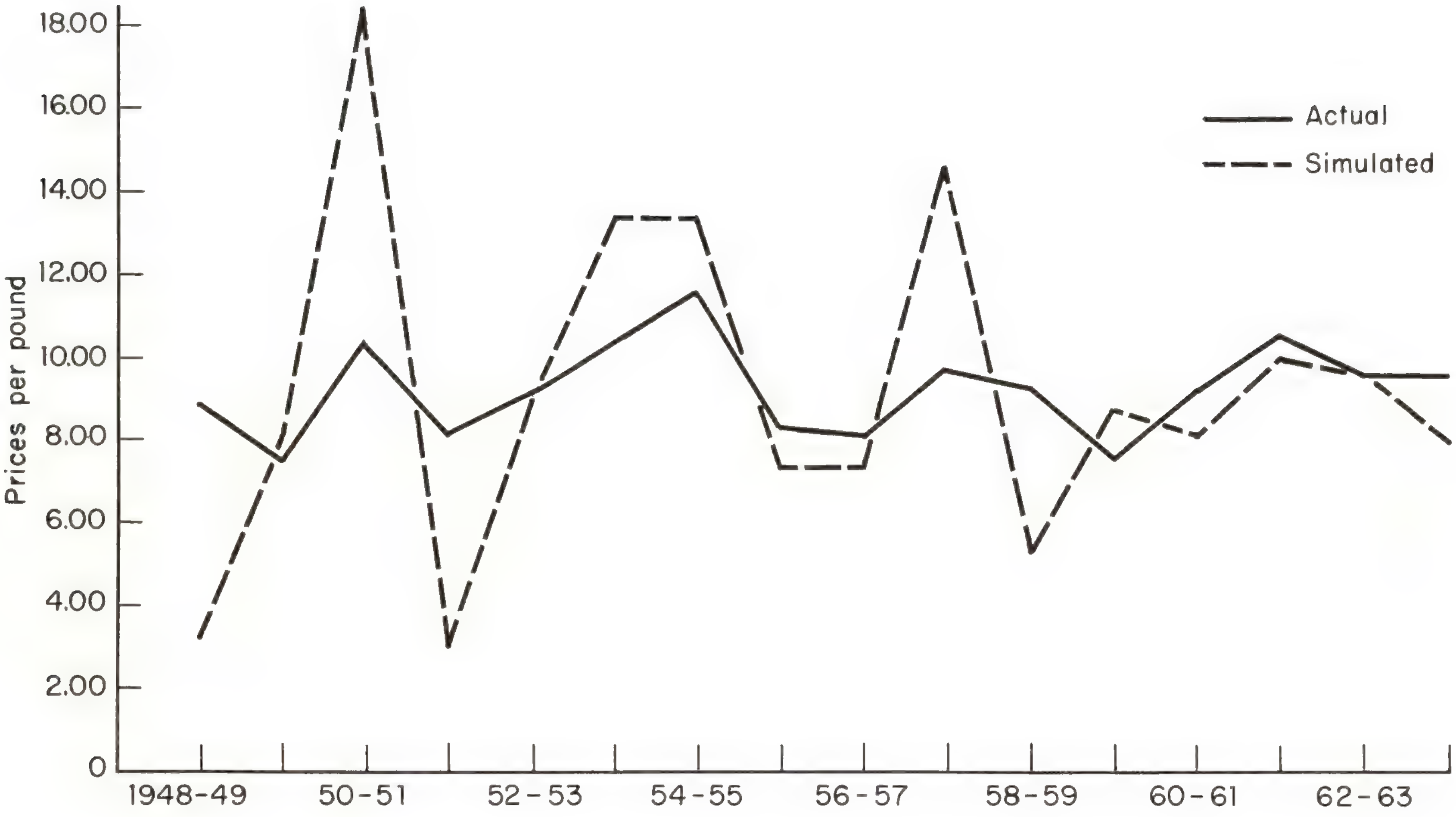

FIGURE 9. Small Whites (Prices Per Pound)

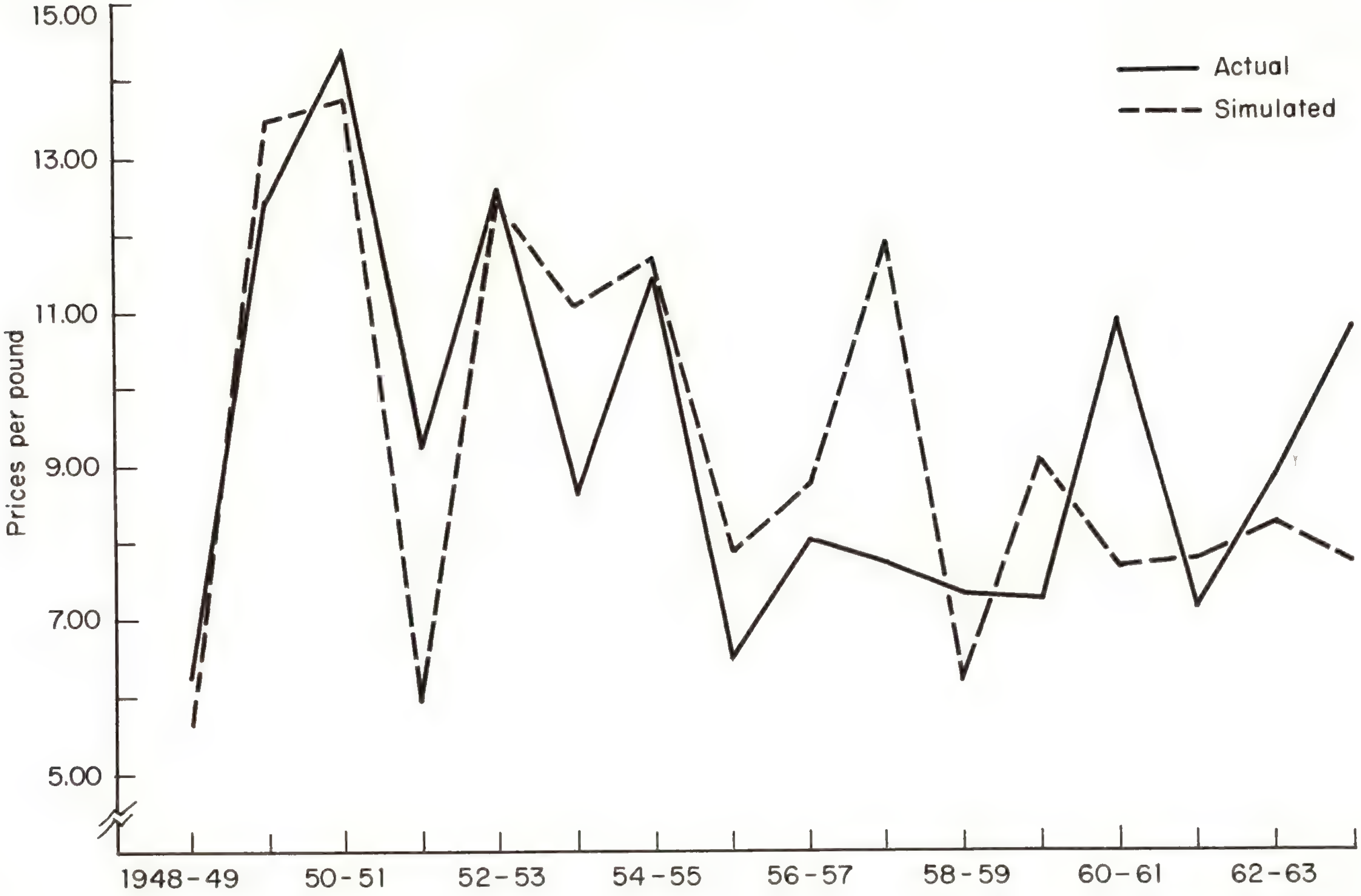

FIGURE 10 Blackeyes (Prices Per Pound)

TABLE 17

Comparison of Supplies and Prices of Dry Edible Beans Obtained on the Basis of the Estimate of the Parameter Structure Under the Assumptions of Absence of Governmental Support[a] and of a Support Price of Navy Beans[b]

Year	Supplies								Takeover		Prices							
	Navy		Small white		Great northern		Blackeye		Navy		Navy		Small white		Great northern		Blackeye	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	per capita								per capita		cents per pound							
1958-59	2.633	2.633	.596	.596	1.173	1.173	.566	.566	.00	.500	4.86	6.86	5.21	6.61	6.49	7.46	6.24	5.92
1959-60	2.736	3.153	.318	.387	.730	.925	.446	.454	.00	.850	5.55	6.86	8.63	8.51	6.13	7.51	9.05	7.32
1960-61	2.563	3.170	.428	.317	.602	1.088	.502	.434	.00	.860	5.82	6.86	8.04	9.23	7.15	7.54	7.68	7.64
1961-62	2.836	3.634	.201	.256	.565	.897	.485	.441	.00	1.182	5.37	6.86	9.85	9.99	6.92	7.62	7.79	7.29
1962-63	2.524	3.462	.349	.354	.625	.847	.481	.437	.00	1.102	6.42	6.86	9.48	9.16	7.48	7.68	8.21	7.18
1963-64	2.877	3.863	.333	.319	.674	.844	.448	.438	.00	1.380	4.32	6.86	7.89	9.63	6.51	7.74	7.72	6.98

[a] Indicated by 1.

[b] Equal to $6.86 per unit, indicated by 2.

The average results for 1960-61 through 1963-64 from simulation 1, simulation 2, and the actual results are as follows. The average CCC acquisitions of navy beans over the last four years, as indicated by simulation 2, are above the actual acquisitions because the former also include the effect of the dummy variable as earlier specified.

	Simulation 1	Simulation 2	Actual results
Navy beans			
Per capita supplies	2.700	3.532	3.830
Average price per hundredweight (dollars)	5.48	6.86	6.78
Small whites			
Per capita supplies	.328	.312	.342
Average price per hundredweight (dollars)	8.82	9.50	9.58
Great northerns			
Per capita supplies	.617	.919	.976
Average price per hundredweight (dollars)	7.02	7.63	7.72
Blackeyes			
Per capita supplies	.479	.438	.453
Average price per hundredweight (dollars)	7.85	7.27	9.36

The results from simulation 2 suggest a favorable effect for the small white variety as a consequence of the effective price support and disposal program for navy beans in recent years. If no donation of navy beans in the small white market had been assumed (they were assumed to be at an annual rate of .062 pounds per capita), the outcome would have been even more favorable. It must be noted, though, that the total improvement for small whites is rather limited.

With respect to the blackeye sector, the evidence does not support the thesis that navy beans are donated in the blackeye market to any significant extent. With an annual donation of .102 pounds per capita of navy beans in the blackeye sector, prices per hundredweight of blackeyes decline from $7.85 to $7.27, whereas the price of navy beans increases from $5.48 to $6.86. Under the assumption that donations of navy beans in the blackeye sector are equal to zero and that the full effect of this is reflected in the average price (supply unchanged), the average price of blackeyes of the years 1960-61 through 1963-64 would be $9.46.

If the favorable effects of an effective price-support program for navy beans on the small white and blackeye markets must be considered negligible to light, provided no significant amounts of navy beans are donated to replace small white or blackeye consumption, this certainly is not the case for the navy bean producers. Both average quantity supplied over the last four years and average price are considerably higher than what free-market forces would bring. The respective increases are 31 percent and 25 percent. It is true that only about half of the amount indicated as CCC acquisitions in Table 12 was actually acquired by the government. The remainder was either directly bought by the government in open-market purchases or disappeared because of sudden unexplainable increases in the commercial demand for navy beans. It is doubtful that the sudden increases in commercial demand would have materialized in the absence of an effective price-support program for navy beans.

Summary and Conclusions

An analysis of the effect of a price-support program with respect to a particular commodity is most complex. To be acceptably realistic, the whole network of demand and supply responses in a dynamic framework must be studied. Such a study involves not only the commodity in question but competing goods as well on both the demand and supply side.

With respect to the dry edible bean sector analyzed in this study, the following main conclusions are offered:

1. Supply response is generally inelastic in the short run and elastic in the long run; elasticities of substitution with respect to quantities demanded are substantial.
2. Navy bean producers, with the exclusion of producers of other bean varieties here considered, have received substantial aid in recent years. This aid has two aspects: In the short run, the government takes over any quantity produced beyond commercial demand at an effective support price; in the long run, the disposal of these acquisitions must be considered a free-of-cost (to the navy bean producer) market expansion program (whether successful or unsuccessful).
3. The gain from this program to producers of competing varieties is negligible to light, provided that disposal of navy beans by the government does not result in substitution of navy beans for competing varieties. There is no evidence that the latter has occurred to any significant extent. The market expansion program for navy beans may also bring some benefits to competing varieties in the long run.
4. Support prices for dry edible beans seem to be established without much consideration of factors particular to the production and disappearance of individual varieties.

APPENDIX TABLE 1

Quantity of Dry Edible Beans Owned by Commodity Credit Corporation as of September 1, 1947-1963

Beginning stock September 1	Navy	Great northern	Small white	Large lima	Small lima
	1,000 hundred-pound bags				
1947	a/	11			
1948					
1949	666	1,698	247		384
1950	2,327	2,719	207	204	947
1951	745	1,378	4		1,005
1952	897	584	152		1,220
1953	50			390	60
1954	1	1		295	
1955				189	240
1956		80		12	83
1957	38	117		47	61
1958				20	
1959					
1960					
1961	296				
1962	404	250			
1963	118				

a/ Blanks indicate stocks equal to zero.

Source: Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division, August 20, 1965.

APPENDIX TABLE 2

Domestic Dispositions of Dry Edible Beans Acquired Under the Price-Support Programs 1950-51 through 1963-64

Marketing year	Navy		Great northern		Small white		Large lima		Small lima	
	Sale	Donation	Sale	Donation	Sale	Donation	Sale	Donation	Sale	Donation
	1,000 hundred-pound bags									
1950-51	1,411	0	496	0	213	0	199	0	--a/	0
1951-52	231	0	198	0	2	0	0	0	0	0
1952-53	b/									
1953-54										
1954-55	36	2	11	1	0	0	9	237	0	0
1955-56	0	0	--	0	0	0	0	48	34	42
1956-57	6	181	1	--	0	0	1	35	0	72
1957-58	45	15	5	0	1	0	13	50	3	66
1958-59	0	0	0	0	0	0	9	0	0	0
1959-60	0	180	0	0	0	0	0	0	0	0
1960-61	362	1,324	0	0	0	0	0	0	0	0
1961-62	143	703	0	0	0	0	0	0	0	0
1962-63	48c/	486c/	156	0	0	0	0	0	0	0
1963-64	39c/	562c/	15	--	0	0	0	2	0	0

a/ Dashes indicate less than 500-pound bags.

b/ Blanks indicate no data available.

c/ Includes small quantity of red kidney beans.

Source: Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division, August 20, 1965.

APPENDIX TABLE 3

Estimated Quantities of Beginning Commercial Stocks of Dry Edible Beans, September 1, 1948-1963

Beginning commercial stocks, September 1	Navy	Great northern	Small white	Large lima	Small lima	Blackeye
	1	2	3	4	5	6
	1,000 hundredweight					
1948	115	182	23	4	57	22
1949	50	50	6	161	12	250
1950	435	69	22	5	15	38
1951	400	297	113	145	84	45
1952	144	219	74	93	33	120
1953	490	428	a/			
1954	74	64	11	0	145	77
1955	50	65	3	50	91	141
1956	150	50	72	130	58	65
1957	244	45	67	106	62	258
1958	25	50	18	49	68	145
1959	30	97	73	108	20	93
1960	363	100	152	71	17	170
1961	160	69	49	53	8	170
1962	32	50	24	107	60	35
1963	338	25	9	158	80	100

a/ Blanks indicate no data available.

Sources:

Cols. 1 and 2:	Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division, November 30, 1965.
Cols. 3, 4, 5, and 6:	California Federal-State Market News Service, *Dry Beans: California Market Summary* (Sacramento, annual issues).

APPENDIX TABLE 4

Income from Grain Sorghum and Barley, California 1947-48 through 1963-64

Year	Grain sorghum			Barley		
	Yield	Price	Income	Yield	Price	Income
	bushel per acre	dollar per bushel	dollar per acre	bushel per acre	dollar per bushel	dollar per acre
1947-48	38.0	2.34	88.92	28.0	1.55	43.40
1948-49	36.5	1.49	54.39	30.5	1.30	39.65
1949-50	38.0	1.43	54.39	29.0	.97	28.13
1950-51	41.0	1.48	60.68	34.0	1.22	41.48
1951-52	40.0	1.85	74.00	30.0	1.51	45.30
1952-53	42.0	1.88	78.96	36.0	1.54	55.44
1953-54	44.0	1.55	68.20	34.0	1.30	44.20
1954-55	52.0	1.49	77.48	38.0	1.16	44.08
1955-56	57.0	1.31	74.67	37.5	1.03	38.83
1956-57	54.0	1.44	77.76	37.0	1.11	41.07
1957-58	56.0	1.22	68.32	40.0	.98	39.20
1958-59	62.0	1.20	74.40	36.5	1.07	39.06
1959-60	63.0	1.14	71.82	39.0	1.03	40.17
1960-61	67.0	1.09	73.03	46.2	1.01	46.66
1961-62	69.0	1.18	81.42	48.0	1.08	51.84
1962-63	67.0	1.19	79.73	51.0	1.09	55.59
1963-64	70.0	1.23	86.10	47.0	1.13	53.11

Source: U. S. Department of Agriculture, Agricultural Statistics, annual issues.

APPENDIX TABLE 5

Income from Corn, Michigan, 1947-48 through 1963-64

Year	Yield	Price	Income
	bushel per acre	dollar per bushel	dollar per acre
1947-48	27.5	2.21	60.78
1948-49	39.0	1.30	50.70
1949-50	48.0	1.26	60.48
1950-51	38.5	1.60	61.60
1951-52	41.5	1.69	70.14
1952-53	50.0	1.50	75.00
1953-54	45.5	1.49	67.80
1954-55	46.0	1.35	62.10
1955-56	46.5	1.25	58.13
1956-57	51.0	1.23	62.73
1957-58	49.5	1.48	73.26
1958-59	56.0	1.09	61.04
1959-60	56.0	1.04	58.24
1960-61	54.0	.99	53.46
1961-62	68.0	.99	67.32
1962-63	65.0	1.05	68.25
1963-64	65.0	1.08	70.20

Source: U. S. Department of Agriculture, Agricultural Statistics, annual issues.

APPENDIX TABLE 6

A. Open-Market Purchases of All Beans[a]

Year	Quantity
	1,000 hundredweight
July 1-June 30	
1956-57	505
1957-58	0
1958-59	0
1959-60	0
September 1-August 31	
1960-61	224
1961-62	730
1962-63	0
1963-64	436

[a] Because D. E. Hathaway did not report any purchases of navy beans during the period 1947-1951 and that quantities produced for the period 1951-1955 were relatively small, it is assumed that for 1947-1955 open-market purchases of navy beans did not occur.

Source: Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division, August 19, 1965.

(Continued on next page.)

APPENDIX TABLE 6--continued.

B. Disposition of Open-Market Purchases of Navy Beans[a]

Year[b]	Needy persons	School lunch
	1,000 hundredweight	
1960-61	120	104
1961-62	289	21
1962-63	0	0
1963-64	292	77

[a] It is not known to us whether open-market purchases have gone or can also go in other channels. In view of this, it is assumed that open-market purchases since 1961 have occurred only in the navy bean sector. Therefore, it is possible that this has resulted in small errors with respect to commercial disappearance of navy beans in 1956-57, 1957-58, and 1961-62 (unallocated amounts being 505.000 hundredweight--July, 1956-July, 1957; and 420.000 hundredweight--August, 1961-August, 1962.

[b] No data available prior to 1960.

Source: Personal communication with the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Policy and Program Appraisal Division, August 23, 1965.